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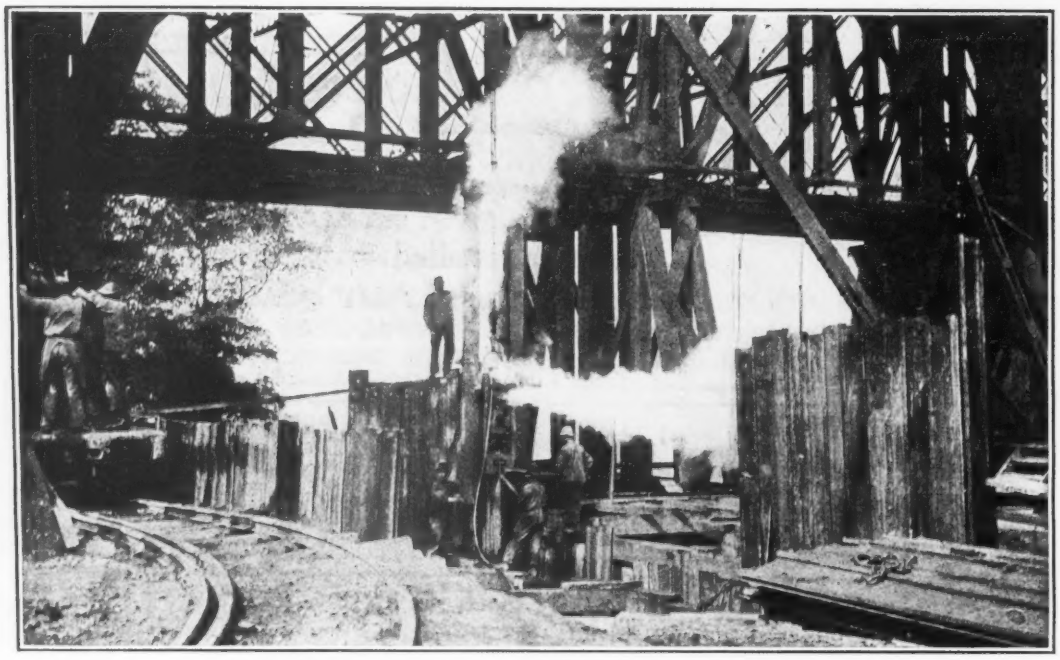

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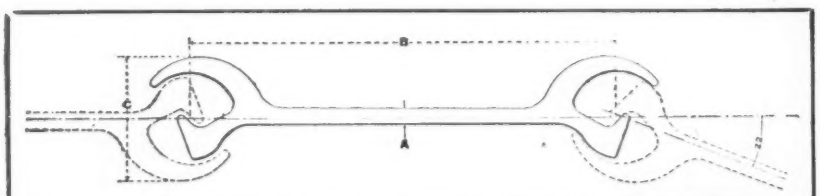

A		B		C
Thickness of Web	Weight per Square Foot of Wall	Distance Center to Center of Joints	Weight per Lineal Foot	Width of Joint Over All
½ inch	40.00 pounds	12¾ inches	42.500 pounds	3½ inches
⅜ inch	35.00 pounds	12¾ inches	37.187 pounds	3½ inches
¼ inch	21.50 pounds	7 inches	12.54 pounds	1½ inches

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ENGINEERING NEWS

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The Colorado River Silt Problem, the Dredge "Imperial" and Irrigation in Imperial Valley, Cal.

By F. C. FINKLE.*

Ever since irrigation first commenced in the Imperial Valley, the silt carried in the Colorado River water has been a source of much trouble and the cause of heavy financial losses. While the silt contains valuable mineral fertilizing qualities and is a benefit to the land when deposited thereon, its deposition in the irrigation canals is a different matter.

Whenever the water attains a velocity in the canals less than that in the Colorado River, its transporting power is lessened and silting begins. As the river velocities vary greatly at the intake of the main canal, it would be impossible to construct a canal, which would, at all times, have the river velocity. Not alone this, but the nature of the soil limits the possible velocities for canals in many cases, and the topography and elevation of land to which water must be delivered fixes the gradient lower than desirable in many others.

Even when it was possible to construct canals with velocities closely approximating those in the river, this would only be for conditions of full flow, and with less water the velocity and silt must both drop.

The difficulties to be encountered from canal silting were foreseen by the writer, when he first made an examination, survey and preliminary plan for irrigating the Imperial Valley in the year 1891. As a result the plan then presented was to divert the water into Volcano Lake through Bee River, where the break occurred in 1910, which the United States Government unsuccessfully attempted to close last summer, and where the Colorado River is still flowing (see sketch map, Fig. 1).

With a safe headgate in Bee River, the water could have been turned into Volcano Lake as required, and after settling in the lake, it could have been diverted into New River, and thence through canals towards the Imperial Valley. This plan would have solved the silt problem for several generations to come and would have prevented the other disasters, which have befallen the valley, but was never carried out, because the financial stringency in 1892 and 1893 compelled the abandonment of the project.

Seven or eight years after 1891, when the project was revived by others, the writer had nothing more to do with it, and his plan was neither known nor disclosed to the new promoters. Instead they diverted the water from the Colorado into the Alamo River, which flows directly to the Imperial Valley, and through it to the Salton Sink. This same Alamo River to-day, with but slight rectification throughout the first 60 miles of its course in Mexico, forms the main canal from Hanlon's Gate on the Colorado to Sharp's Heading, from which distribution of water to the Imperial Valley begins.

As soon as the diversion into the canal was made, silt was deposited, gradually raising the canal level, until the first intake had to be abandoned and a new one cut. The same fate befell the second intake, and "Intake No. 3" was constructed lower than the previous ones. It would likewise have silted up, but the several floods in the river early in 1905 widened and deepened it until the whole Colorado flowed through it toward Salton Sea. This could not be prevented, because there was no headgate to regulate the water, and the disastrous overflow, which threatened to convert the Imperial Valley into an inland sea, continued until 1907, when the break was finally closed by the Southern Pacific Railroad Co., after many failures and the expenditure of millions. (Eng. News, Vol. 56, No. 26, pp. 671 to 676; Vol. 57, No. 8, pp. 216 and 217; and Vol. 58, No. 2, pp. 26 and 27.)

About the same time a new intake was excavated farther up the river at Hanlon's Heading and a permanent concrete headgate constructed in the canal about 1,600 ft. below the intake. (This headgate may be seen in the view, Fig. 3.) The sill of this gate was placed at an elevation of 98 ft. above sea level, which is from 8 to 9 ft. lower than the surface of water in the river at this point during its low stage. This was believed to be sufficiently low to admit all the water needed, even should some silt be deposited.

But each year, when the Colorado became low, after the spring and early summer flood, there was a shortage of water. The large amount of silt carried at flood time caused a deposit to form in the canal both above and below the gate. With each year the elevation of the canal bottom rose, and the water famine became a little worse, both on this account and because the increased acreage under cultivation required more water.

In the meantime judgments for damages on account of the overflow from 1905 to 1907, expenses for closing the break and damage claims for the annual shortages of water made the

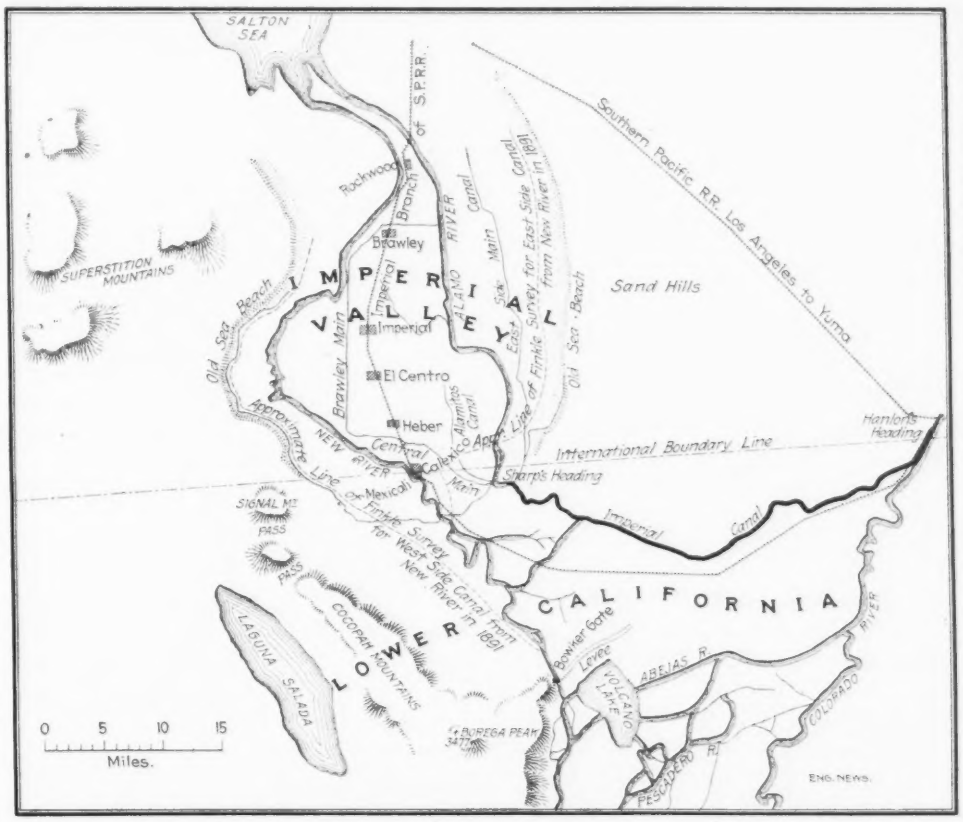

FIG. 1. SKETCH MAP OF IMPERIAL VALLEY AND CONTIGUOUS TERRITORY IN UNITED STATES AND MEXICO, SHOWING MAIN IRRIGATION CANALS.

*Consulting Engineer, Los Angeles, Cal.

California Development Co., owner of the main canal system, bankrupt, and in 1909 it was placed in the hands of a receiver.

In the midsummer of 1910, under the receivership, came the final crisis regarding water deliveries. There had been a serious shortage of water in March and April, 1910, while the river was low, and much damage to crops had resulted. In the latter part of June the river again fell and the receiver was unable to fill all orders for water.

After that the condition became rapidly worse, as the Colorado declined in volume, and by the middle of July orders for water stood 1,400 sec.-ft. and deliveries were 800 sec.-ft. The crops were already much injured and a continuance of the water shortage would soon destroy what remained, cause losses amounting to millions of dollars and deal a death blow to the Imperial Valley with its 15,000 population and property assessed at nearly $10,000,000.

The receiver and his engineers proclaimed that nothing but a diversion weir in the Colorado below the intake, to raise the water level, and thus force more water into the canal, could save the valley. The Colorado, being a navigable stream, permission to construct a weir must come from the War Department.

The water was then, the same as now, distributed to seven mutual water companies under contracts with the California Development Co. and paid for at 50 cts. per acre-foot. The stockholders in these mutual water companies were the real parties in interest, and the crops on the 200,000 acres, or more, of land irrigated by them were suffering. Impatient at the delay and uncertainty, Mr. Thomas O'Brien, one of the directors of Imperial Water Company No. 5, employed the writer to visit the main canal and make an investigation to determine the condition of affairs and recommend what should be done.

This investigation was begun at Hanlon's Heading on July 21, 1910, and continued by traversing the entire canal and taking soundings and levels. It was found that the canal was silted up for nearly five miles below the intake, being from 5 to 6 ft. above grade, as fixed by the sill of the concrete gate, in the upper mile, and diminishing gradually throughout the next four miles.

With a gage height of 107.4 ft. in the canal above the concrete gate it was only possible to deliver 600 sec.-ft., while with an unobstructed channel 2,500 sec.-ft. could have been delivered. The irrigators were calling for 1,500 sec.-ft.

It was apparent that the real remedy was dredging to remove the silt from the canal. The receiver had three dredges, a clam shell, a dipper and a drag-line bucket dredge, but these were all unsuited for handling the indurated silt expeditiously and economically. With a suction dredge of proper capacity relief could have been obtained in a short time, but this should have been planned many months before, when the first shortage of water occurred in March, and there was yet time to construct a suction dredge before the expected low river following the spring rise.

Hence, the receiver's plan was the only one by which a part of the crops might be saved, and a united effort on part of the mutual water companies and the receiver resulted in securing permission from the War Department to install a temporary pile trestle and dump rock to serve as a weir for raising the river level at the intake. In this emergency, President Taft did his best for the Imperial Valley by using his influence with the War Department, and the temporary weir was installed with the understanding that it should be removed whenever the War Department should so order. Director F. H. Newell, of the U. S. Reclamation Service, also used his influence to secure permission to build the temporary weir.

The work was rushed with all possible speed and by Sept. 1, 1910, the water level had been artificially raised (see Fig. 2) so as to force all the water required through the canal in spite of its silted condition. In the meantime the lack of water had done more than one million dollars worth of damage to the crops, and silt was still being deposited in the canal more rapidly than it could be removed by working the drag-line bucket dredge, which had been in operation continuously since the latter part of July.

The success of the temporary weir apparently caused the receiver to believe that its removal before high water, and re-installation thereafter each year, was the true remedy against future water shortages. This was a costly thing to do, each removal and reconstruction being estimated to cost $40,000, and there was no assurance that it would again be permitted. But the receiver laid his plans to do it, and also to operate the clam shell, dipper and drag-line dredges to hold the silt down to a point where the weir might continue to be effective.

After figuring the expense of carrying out this program, the receiver concluded that the revenues from water at 50 cts. per acre-foot would be insufficient to meet expenses, and forthwith applied to the court to increase the water rate to 80 cts. per acre-foot. To this the seven mutual water companies made earnest objection, claiming that a suction dredge to remove the silt was the proper remedy, and within the receiver's purse.

The matter was tried in court, principally on the testimony of experts, for two weeks, but before it was submitted to the court for a decision the receiver offered to pay rental for a

Fig. 2. Trestle Built Across the Colorado River in Summer of 1910 to Create a Temporary Weir to Raise Water Level at Intake of Imperial Canal.

(View taken Feb. 14, 1911.)

suction dredge, to be built and owned by the mutual water companies, on a basis to pay them for interest on the investment and depreciation of the dredge, and to maintain and operate the dredge at his expense. If this should be accepted the receiver agreed to collect the old rate of 50 cts. per acre-foot for water.

The result was the execution of a contract between the mutual water companies and the receiver providing that the companies should design and construct a suction dredge of not less than 12-in. pump, and rent it for 10% per annum on its cost on condition that the rates to be charged for water should continue at 50 cts. per acre-foot, the receiver to purchase the dredge as soon as he could accumulate a surplus for so doing. Further, the contract provided that the water companies might select a consulting engineer "to inspect the dredge at all reasonable and convenient times, and to inspect the operation thereof, the manner of its use, and the purposes for which it is used, and to make recommendations to the receiver;" the engineer of the water companies is also to "have free access to inspect any work being performed by the receiver, and to confer with him regarding the advisability of the same."

For the purpose of carrying out their part of the contract all the mutual water companies, known as Imperial Water Co. No. 1, No. 4, No. 5, No. 6, No. 7, No. 8 and No. 12, met and selected Messrs. J. J. Strieby, George O. Long, George H. Reed, W. H. Best and J. T. Rice a permanent committee to look after their interests, and appointed the writer as consulting engineer to advise them and to act under the contract.

By the middle of November, 1910, the plans and specifications for a 15-in. pump suction dredge had been completed, and on Dec. 10 the contract for its construction was awarded to the North American Dredging Co., of Nevada, for $57,300. This construction contract provided that the dredge should be completed by April 10, 1911, a bonus of $200 per day to be paid for each day it should be completed before that time, and a penalty of $200 per day for each day thereafter.

The dredge (Figs. 3 to 7) was completed eleven days ahead of the time agreed, and the contractors received $2,200 bonus, which was gladly paid, as it gave ample time to do the work required to prevent a water famine in 1911. After this a rigid test provided for in the specifications, which called for at least 240 hours actual running out of 15 days and the excavation of not less than 175 cu. yds. of solid material per hour's run, was commenced

Following is the record of operation during the test, copied from the summary of the log book kept by the representative of the mutual water companies' consulting engineer during the test.

Very few rocks were caught in the rock chest, those which were found being left there from the construction of the concrete gate, but frequent cleaning was necessary on account of

RECORD OF OPERATION FOR DREDGE "IMPERIAL" FROM MARCH 31, 6:40 P. M. to APRIL 16, 3:35 P. M., 1911.

Period in day, p. m. to p. m.					Time in hours and minutes. Net running.		Stops.		Cause of stops.
6:40	3/31	to	6:40	4/1	18	00	6	00	Swinging stern, extending discharge pipe, moving pontoons, taking oil on board, cleaning pump, removing rocks from rock chest and washing back.
6:40	4/1	to	6:40	4/2	18	48	5	12	Moving dredge, cleaning pump and discharge table, starting engine, changing port cable, and removing rock from rock chest.
6:40	4/2	to	6:40	4/3	12	19	11	41	Repairing oil pump, cleaning pump, lack of fuel oil, and washing back.
6:40	4/3	to	6:40	4/4	11	05	12	55	Changing shore pipe, cleaning pump, raising ladder, repairing oil scow, and washing back.
6:40	4/4	to	6:40	4/5	15	20	8	40	Cleaning pump, priming discharge pipe, cleaning suction, changing pontoons and washing back.
6:40	4/5	to	6:40	4/6	15	10	8	50	Removing rock from rock chest, cleaning pump and washing back.
6:40	4/6	to	6:40	4/7	19	40	4	20	Cleaning and priming pump, working on engine and washing back.
6:40	4/7	to	6:40	4/8	20	03	3	57	Cleaning pump, moving dredge, low steam pressure, changing pontoons and washing back.
6:40	4/8	to	6:40	4/9	00	00	24	00	Cleaning boilers and repairing engine. Sunday.
6:40	4/9	to	6:40	4/10	10	12	13	48	Cleaning boilers and washing back.
6:40	4/10	to	6:40	4/11	19	44	4	16	Chocked suction, cleaning pipe, placing pontoons and washing back.
6:40	4/11	to	6:40	4/12	17	25	6	35	Cleaning and priming pump, changing suction pipe, changing pontoons and landing, and washing back.
6:40	4/12	to	6:40	4/13	19	23	4	37	Cleaning pump and stone chest, changing pontoons and washing back.
6:40	4/13	to	6:40	4/14	14	49	9	11	Delay from sand storm, cleaning pump and stone box, priming pump and changing pontoons.
6:40	4/14	to	6:40	4/15	17	07	6	53	Washing back, changing landing and pontoons and cleaning stone box.
6:40	4/15	to	3:25	4/16	14	46	5	59	Washing back, changing landing and pontoons and cleaning stone box.
	Total				243	51	136	54	

Washing back refers to suddenly stopping the pump to permit drift lodging against the lower end of the suction pipe to float away.

drift and other matter found in the silt of the canal.

The total quantity excavated during the test was slightly over 49,000 cu. yds., at the rate of approximately 201 yds. per hr. The cost of the test was as follows:

Transportation of crew	$232.70
Labor as per pay-roll	1,055.82
Commissary	266.73
Repair parts used	51.40
Fuel oil, lubricating, waste, packing and other usual dredge supplies	972.26
Total	$2,578.91

About 26,000 gals. of 16 gravity fuel oil costing 3¼ cts. per gal. delivered on the dredge were consumed during the test. Cost per cubic yard of solid material moved, which was lifted to an average height of 35 ft., was 5¼ cts.

The cost of the dredge "Imperial" was as follows:

Contract price	$57,300.00
Bonus for advance completion	2,200.00
Extras not included in plans and specifications	950.88
Engineering for designing and supervising construction	2,066.23
Inspectors	247.93
Expenses of Water Companies' Committee and Secretary	499.89
Legal advice preparing contract, bond on final settlement, etc.	325.00
Total	$63,589.93

After the test the dredge was accepted and turned over to the receiver for operation. It has been under the charge of Mr. J. C. Allison, Chief Engineer for the receiver, who has operated it continuously since April 23, 1911. Mr. Allison's first report covering the operation from April 23 to June 17, 1911, gives the following data:

COST OF OPERATION.

Labor, including surveys for measuring yardage	$2,987.26
Commissary	750.00
Material for repairs, etc., other than fuel	495.46
Fuel oil	1,708.10
Total	$5,940.82
Solid material moved	122,105 cu. yds.
Cost per cubic yard	4.86 cts.
Total running time	589 hrs.
Output per hour	207.3 cu. yds.
Average fuel used	2 bbls. of 16 gravity oil per hour of running time

From this it is observable that the work of the dredge improved after the first test, which is usual in any well-designed piece of machinery.

Now, as to what the dredge "Imperial" has accomplished for the Imperial Valley in solving the silt problem in the main canal, the following are interesting facts: When dredging commenced on April 1, 1911, the elevation of the canal bottom at the intake was 104.5 ft., being 6.5 ft. above the concrete sill of the intake gate. About 3½ miles down the elevation was 99 ft., having raised nearly 1 ft. since July, 1910, and intermediate points in proportion. On Aug. 15, 1911, the highest point in the bottom near the intake gate was 99.1 ft., only 1.1 ft. above the sill, and the elevation about 3½ miles below was 93.4 ft. Points between were on practically a uniform slope.

On Aug. 19, 1911, the river gage at the canal intake read 107.4, and 2,158 cu. ft. per sec. were admitted into the canal. This was ample to supply all demands and take care of the loss in the sixty miles of channel from the Colorado River to the beginning of distribution at Sharp's Heading, the orders for water standing about 1,700 sec.-ft. If the channel had not been dredged the maximum quantity, which could have been diverted, would have been 700 sec.-ft. with the river gage at 107.4, and from this only 300 to 350 sec.-ft. would have reached Sharp's Heading.

Such a condition would have meant the destruction of practically all crops in the Imperial Valley the present season, as 300 sec.-ft., equally distributed among all users, as it would have to be in such an emergency, would not have allowed any one to mature a crop. The trestle for a temporary weir could have not been replaced against the objection of the U. S. Reclamation Service, which demanded its removal early in 1911, as the U. S. War Department did not care to assume the responsibility of acting adversely to the Reclamation Service.

The construction and operation of the dredge "Imperial" has accomplished three things: (1) it has saved the Imperial Valley from loss of the 1911 crops worth several million dollars; (2) it has restored confidence in the value of Imperial lands; and (3) it has demonstrated that there is a way to counteract the Colorado River silt.

While all of these things are extremely important, the last is of general importance as bearing on the operation of canals from silt laden rivers. When material can be dredged for less than 5 cts. per cu. yds. with fuel oil at from $1.40 to $1.50 per bbl., the cost of removing silt does not create a high operating cost. It has cost less than $15,000 to remove the silt accumulated from deposits in the main Imperial Canal during the last four years. This canal is 80 ft. wide on the bottom and the silt cleared out extended down it for nearly five miles.

Based on the experience had in this case, the

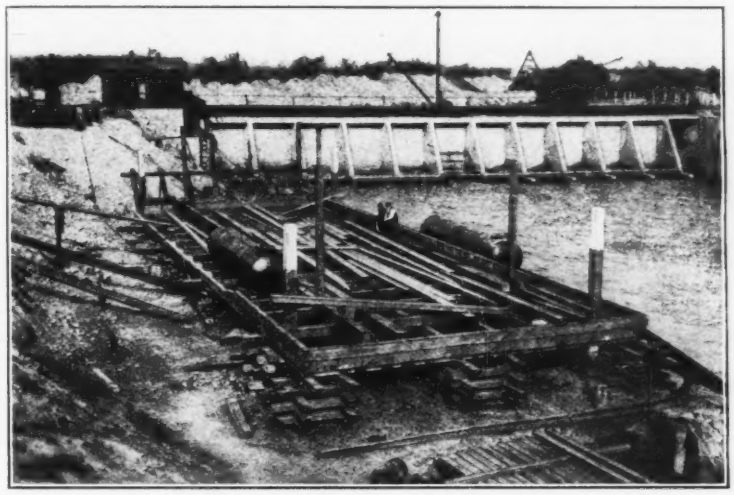

Fig. 3. Jan. 23, 1911: Framework for Hull Laid Out. Hanlon's Heading in Background.

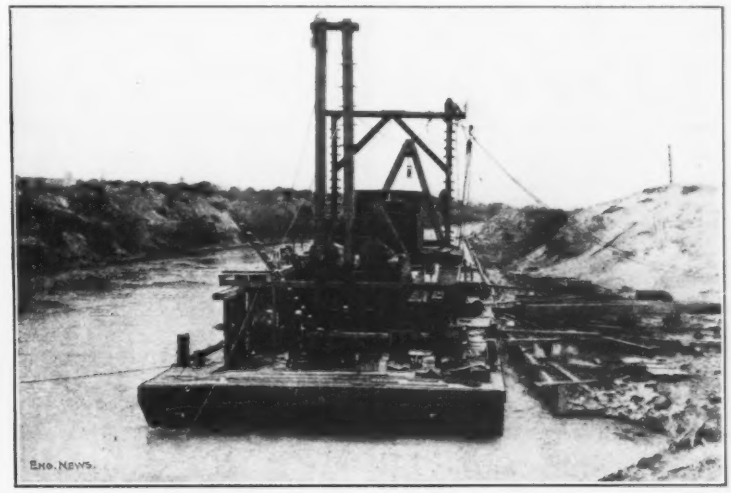

Fig. 4. March 5, 1911: Boilers and Part of Framework on Deck in Place.

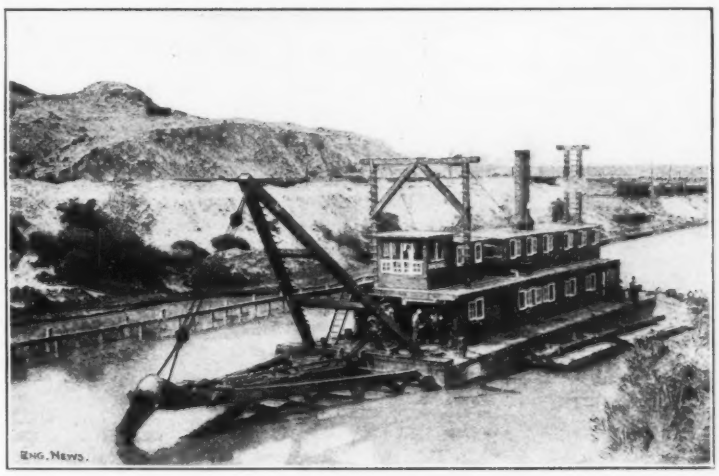

Fig. 5. April 9, 1911: Ready for Service.

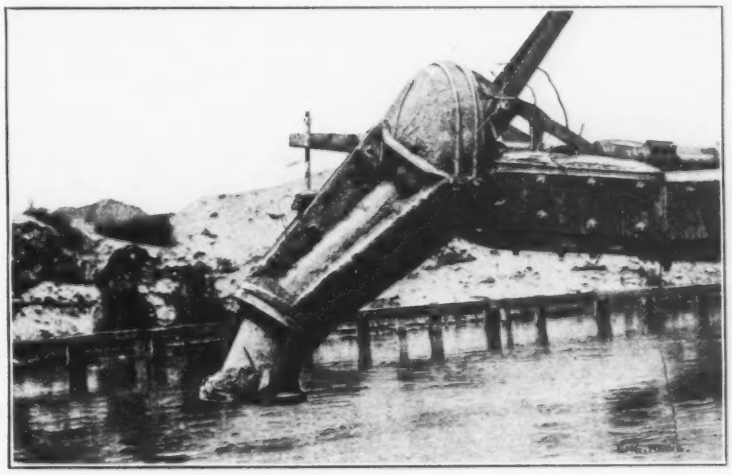

Fig. 6. Nozzle on Ladder.

FIGS. 3 TO 6. HYDRAULIC DREDGE IMPERIAL UNDER CONSTRUCTION AND READY FOR OPERATION; MUTUAL WATER COMPANIES, IMPERIAL VALLEY, CALIFORNIA.

problem can be solved by operating a suction dredge occasionally in canals of this class at some point not far below the intake. When this is done, so as to deepen the canal section below the grade for some distance, the incoming silt will settle into the cavity, and dredging need only be resumed after it has become refilled.

In new canals, designed to divert water from rivers like the Colorado, a settling basin of proper dimensions should be constructed near the intake. Where opportunity does not exist for sluicing out such basins by gravity the solution lies in periodic dredging to accomplish the same purpose.

That this can be done economically has been fully demonstrated by the dredge "Imperial," for which reason it may be pardonable to give the following brief synopsis of the specifications from which it was constructed:

HULL of wood 33 × 96 ft. inside fenders and 8 ft. deep. Bottom, 4 × 12 ins.; deck, 3 × 8 ins.; sides, 6 × 12 ins., and two 8-in. bulkheads fore and aft.

KELSONS: Eight fore and aft and 19 across, 8 × 10 ins.

TRUSSES on each side 14 ft. high; lower chord, 8 × 8 ins.; upper chord, 8 × 12 ins.

QUARTERS two stories above deck to enclose machinery, living quarters and pilot house.

SIDES of 1 × 6-in. tongued-and-grooved pine.

TOILET and bathroom.

SPUD WELLS of cast-iron on rear of hull. Fitted with end flanges securely bolted and cemented with sulphur.

SPUDS 40 ft. long, 24 ins. square, with forged-steel point and angle chafing bars.

A-FRAME of two 16-in. timbers with 12 × 12-in. cross timbers. A-frame to raise on cast-iron brackets fastened to deck with bolts terminating in chain plates.

GALLOWS FRAME from A-frame of 12 × 12-in. timbers, securely bolted to bulkhead and upper chord of truss, and cross braced with 3 × 12-in. timbers; on each side a cast-iron saddle for stay wires.

SPUD MASTS 12 × 16 ins., 40 ft. long, located between spud wells and provided with cross top timbers.

FOUNDATION UNDER MAIN ENGINE two solid layers of 12 × 12-in. timbers raised on kelsons.

FOUNDATION FOR WINDING MACHINERY laid up of 8 × 12-in. timbers and under cutter gearing of 12 × 12-in. timbers, with all auxiliaries raised on substantial timber foundations.

BOILERS of the Heine type with semi-marine setting. Installed with one battery with single smoke stack 36 ins. in diameter. Top drums covered with 1-in. asbestos blocks. Boiler working pressure, 165 lbs. Tested to 240 lbs. at factory. Drums, 36 ins. in diameter, 19 ft. 4½ ins. long, of ¾-in. plate. Tubes, 3½ ins. in diameter and 16 ft. long, of No. 11 B. W. G.; except lower rows of No. 9 B. W. G. Grate surface for each boiler, 53 ins. wide by 54 ins. long.

FOUNDATION FOR BOILERS of steel rails 5 ins. high, placed as grillage in concrete covered with steel plate and lined with asbestos.

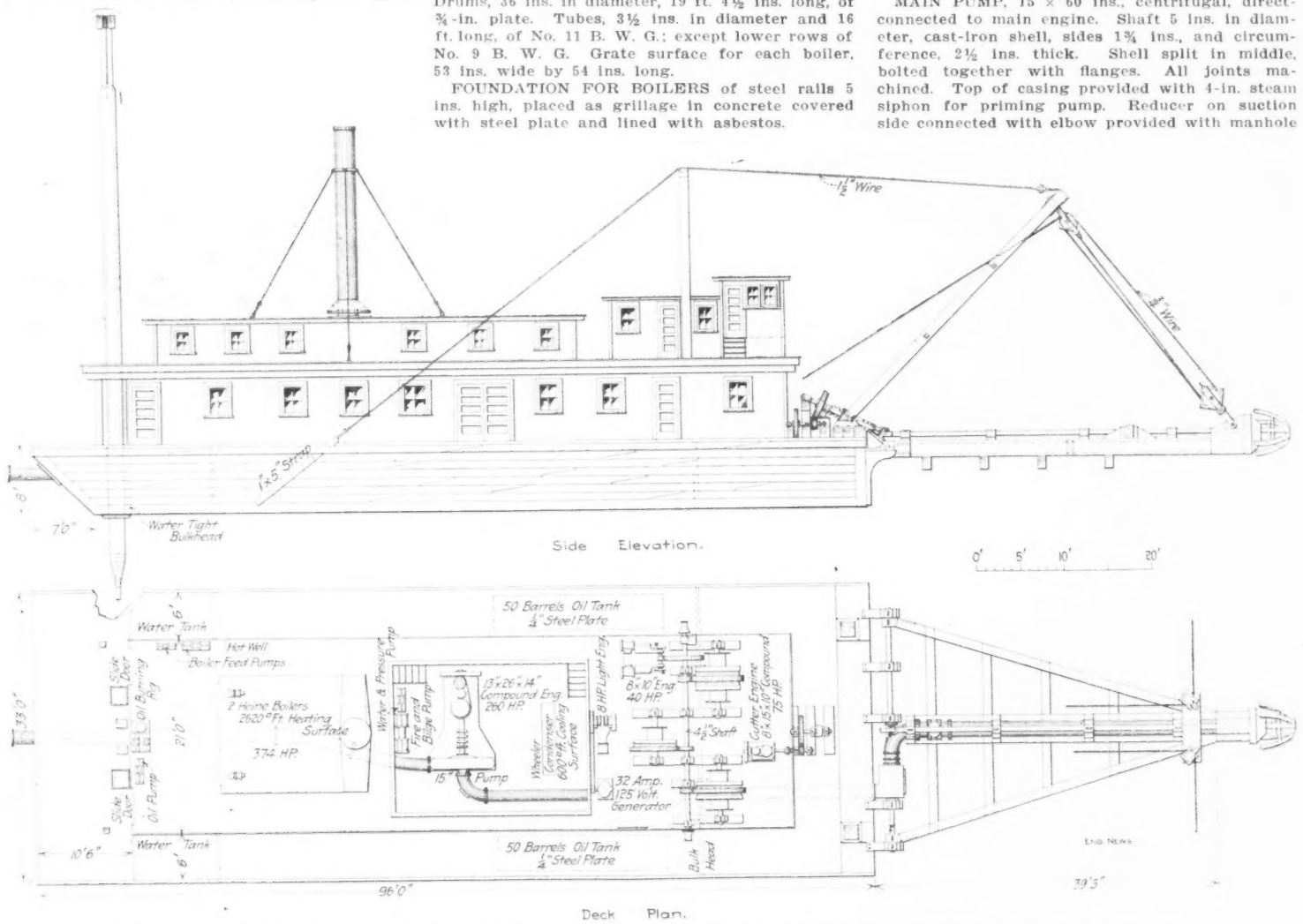

FIG. 7. PLAN AND ELEVATION OF DREDGE IMPERIAL; MUTUAL WATER COMPANIES, IMPERIAL VALLEY, CALIFORNIA.

MAIN ENGINE of vertical compound two-cylinder Marine type, without links, 13 × 26 × 14-in., to rest on cast-iron sub-base, which will also support main pump. Crank shaft of forged steel bearings of babbitt, horseshoe thrust on crank shaft between engine and pump. Piston and connecting rods are forged steel, crank brasses of bronze, cross heads of cast-steel babbitted on slides. Piston of cast-iron with two cast-iron snap rings to a piston. High-pressure valve of piston type and low-pressure valve of "D" slide type. Valves of cast-iron and seats of same. The valve stems of forged steel. Running speed, 250 r. p. m., with steam pressure 150 lbs. Cylinder lagged with asbestos and covered with sheet metal. Engine provided with governor and sight-feed oilers, and to develop 260 HP. if required.

CUTTER ENGINE same as general design for main engine except size, and without extra sub-base or horseshoe thrust bearings. Cylinders, 8 × 15 × 10 ins. Cutter engine will be connected to cutter gearing with cast-steel pinion on crank shaft. Provided with outboard bearing and balance wheel on opposite end of crank shaft. Speed of cutter engine, 235 to 260 r. p. m.

WINDING ENGINE: Two-cylinder, horizontal simple engine, 8 × 10 ins. Cylinders connected together with cast-iron bed plate, and crank shaft provided with cast-steel pinion to engage winding gear. Connecting rods, piston rods, pins and crank shaft of forged steel. Crank shaft with babbitted bearings and crank brasses of bronze. Crosshead of cast-steel. Piston and piston rings, cylinder and base of cast-iron.

SURFACE CONDENSER with 600 sq. ft. cooling surface, 1-in. brass tubes, with air and circulating pump direct-connected to steam cylinders; size, 7½ × 10 × 10-in. stroke. Heater of Riley multicoil of enclosed type for heating water to 180° F. Boiler-feed pumps, two, duplex 6 × 4 × 6-in. piston-packed and brass-fitted throughout. Oil-burning rig of two duplex pumps 3 × 2 × 2 ins. mounted on base with oil heater, automatic regulating valve, air tank and strainers.

MAIN PUMP, 15 × 60 ins., centrifugal, direct-connected to main engine. Shaft 5 ins. in diameter, cast-iron shell, sides 1¾ ins., and circumference, 2½ ins. thick. Shell split in middle, bolted together with flanges. All joints machined. Top of casing provided with 4-in. steam siphon for priming pump. Reducer on suction side connected with elbow provided with manhole plate. Suction and discharge pipe of seamless tubing with cast-iron flanges.

SUCTION PIPE provided with stone box with manhole.

BILGE PUMP: Duplex, 6 × 5¾ × 6 ins., with 4-in. suction.

WATER PUMP: Duplex, 5¼ × 3½ × 5 ins., with 2½-in. suction and 2-in. discharge.

OIL-PUMP: Duplex, 5¼ × 3½ × 5 ins., with 2-in. discharge.

GAGES with 8-in. face for boiler room as follows: Steam gage, vacuum gage on condenser, compound gage on main engine, pressure gage on discharge pipe, vacuum gage on suction pipe and pressure gage on pipe supplying water to main pump bearing.

STEAM PIPING: 4-in. size to main engine, 3 × 2½ ins., in duplicate, to auxiliaries, 2-in. pipe joined with screw joints and unions, and larger than 2-in., with flanges.

VALVES ON STEAM LINES: Lunkenheimer globe and angle. Globe gate valves of standard makes on exhaust lines.

WATER PIPING IN HOLD, galvanized, with gate valves and oil piping black, with gate valves.

HOT WELL of steel plate covered with screens and flashboards.

OIL TANKS: Two in each wing of hold, 15

bls. each, of ¼-in. steel plate, piped to oil burner pumps, and provided with 2-in. filling pipes.

WATER TANKS: Two in hold, divided into two compartments, each holding 25 bbls. of water. Designed to settle silt before using water.

LIGHT PLANT of 8-HP. horizontal engine, belted to 32-ampere, 135-volt Westinghouse generator, with marble switchboard and instruments. Wired in three circuits to hold, and levels above deck.

LADDER of timbers braced with iron, and on cast-iron hinges and bearings, with seamless tubing suction pipe and elbows below stone box.

CUTTER SHAFT: Three length of 6-in. nickel steel, joined with steel jaw couplings, with keys at right angles.

CUTTER GEARINGS in two pairs of cast-steel. Pinion on engine shaft, 6-in. face, 2½-in. pitch. Cast-steel gear on intermediate shaft, 6-in. face, 11½-in. P. D. and 2¼-in. pitch. Cast-steel bevel pinion on intermediate shaft, 3-in. pitch, 10-in. face, 12 teeth. Gear on cutter shaft, 10-in. pitch, 3-in. face, 48 teeth. Intermediate shaft, 4-ins. in diameter, of hammered steel. Ratio of engine revolutions to cutter shaft, 18 to 1.

UNIVERSAL JOINT between section of shaft with bevel gear and end of cutter shaft, consisting of two pairs of jaw couplings and sliding sleeve of cast-steel. Cross toggle of cast-steel and jaws will be bronze bushed for cross-toggle pins.

WINDING MACHINERY of two double drums and one single drum with shafts 6½-in. hammered steel, and main shaft across deck, 4½-in. steel, with two gypsies. Gears and drums of cast-iron, 16½ ins. in diameter and 16 ins. long. Frictions, 4 ft. 4 ins., V type of hard maple with brakes, all connected to levers in pilot house.

LEVERS: Five brake levers and five friction levers and throttle on swinging engine and cutter engine.

CUTTER of cast-steel spider and cast-steel blades, bolted to cutter spider.

NOZZLE of cast-iron to take place of cutter in soft material and made on angle to strike bottom at right angles to ladder when down, attached to end of suction pipe when cutter is removed for using nozzle.

SHEAVES of cast-steel, with solid webs and brass bushings. Easily removable.

CABLES for spuds, 1 in. in diameter.

PONTOONS: Ten 24 ft. long, 8 ft. wide, 32 ins. deep; sides, 4-in. plank; bottom and deck, 2-in. plank; frame timbers, 4 x 6 ins., with intermediate posts throughout.

PONTOON PIPE: 300 ft. 8 B. W. G. 15 ins. in diameter, in 30-ft. lengths, and provided with 1½-in. oval bands for connections and rubber hose couplings.

SHORE PIPE: 600 ft. slip joint of No. 10 B. W. G. steel in 20-ft. lengths and 15 ins. in diameter, with 1½-in. half oval band for connection.

TOOLS: Full equipment for repairs on dredge, including 24-in. drill press, bolt cutter, blacksmith's forge and tools, emery wheel, lathe, jack screws, chain tackle, all belted and driven by light engine.

When the dredge "Imperial" was first started the cutter was installed for the ladder, but it was found that the silt, although packed so hard that a drag-line bucket, a clam shell or a dipper dredge could not attack it successfully, was so light it would float away from the suction pipe, as soon as loosened by the cutter. The cutter was then replaced by the nozzle and the highly satisfactory operating conditions herein related were obtained. The dredge has been operated with the nozzle up to the present time and it is exactly the proper thing for silt of the Colorado River variety.

Every part of the dredge has performed its part perfectly and no interruptions of moment have occurred, except for cleaning the boilers, which is necessary every Sunday on account of the silt in the boiler-feed water, in spite of the settling given it in the tanks.

To give some idea of the magnitude of irrigation operations in the Imperial Valley, the following statistics may be of interest in closing this discussion:

During the year 1910 about 500,000 acre-feet of water were used for irrigation, and from the returns to Sept. 1, 1911, it is probable that 625,000 acre-feet will be used in 1911.

The maximum quantity of water diverted from the Colorado River on any one day during 1911 was 3,200 cu. ft. per sec.

There are over 1,000 miles of main distributing canals and laterals in the valley in actual use.

About 250,000 acres are now being irrigated out of nearly 500,000 acres susceptible of irrigation.

Legal Compensation for Engineers Engaged On Public Works in Indiana.*

By EDWIN E. WATTS.†

When one carefully considers the compensation at present authorized by statute for engineering work within this State, then it becomes apparent that high-class professional engineers cannot be possibly attracted to these works. The present compensation authorized by statute for these works is as follows:

City Civil Engineers.

Cities of first class, maximum $3,500.00 per annum.
Cities of second class, maximum, $2,500.00 per annum.
Cities of third class, maximum, $1,500.00 per annum.
Cities of fourth class, maximum, $1,000.00 per annum.
Cities of fifth class, fixed by ordinance of the Common Council.

(Acts 1907, page 278).

In county engineering, the following are the prices which prevail:

Supervision of highway bridge construction (when employed) $2.00 per day.
For surveying public highway, $2.50 per day and 5 cts. for each mile traveled. For making report of survey, $1.00; and if over five miles, $2.00.
For gravel road design and construction, $3.50 per day and expenses. (Acts 1907, p. 521).
The location and supervision of construction of drainage works, $4.00 per day. (Acts 1907, p. 508).
Ditch repair, $4.00 per day. (Acts 1907, p. 606).
Location, design and supervision of construction of levees, $4.00 per day. (Acts 1907, p. 407).

The few annual salaries fixed by law are grossly inadequate and still more inadequate is the per diem rate fixed for county works. Take for example the engineer of a large drainage or levee project. He has to perform the work, bear his own expenses, has to remain idle—or at least not engaged upon the work—during the interim between the filling of his report and the establishment of the project by the courts, then if the project is established, whenever the money is collected from the assessments, he is entitled to receive his compensation, often covering a period of two, three and sometimes four years, depending upon the amount of litigation to which the particular project has been subjected.

During the progress of construction, the courts in all probability have appointed as commissioner of the work some person—a political favorite generally—who has no idea whatever of the professional part of construction supervision and must depend upon an engineer whom he employs, not regularly but only intermittently, and all at the compensation fixed by statute of four dollars per day.

Can any member of this Society imagine the engineer of maintenance of a railroad company supervising new construction or betterment to the value of $50,000 to $100,000 receiving as a total compensation for the engineering of this amount of construction work, a fee not exceeding five or six hundred dollars; or can the average professional man appreciate the fact that the engineer of a large levee project may have to work three or four years at the statutory compensation of four dollars per day (without actually receiving cash), have the matter defeated in the courts at final hearing and then have to go through the long drawn out and expensive process of suing the petitioners for the improvement upon their cost bond with the possible recovery of a judgment of a few hundred dollars for a long and arduous service?

The result of the meager and miserly pittance which is allowed for engineering of public works within this State, falls primarily upon the taxpayer because high class men cannot possibly be attracted to these works. If they do attempt any such works, it is only a short while until they will refuse to accept any further appointments because of the scanty pay and the irregular method provided for its collection.

Oftentimes engineers of high qualification are so situated that they are compelled to accept commissions upon these works and to suffer the inconvenience and delay of meager pay to the end of the work, but certainly such men cannot enter into their work, giving a spirit loyal to their employment that those men do whose compensation is fixed upon a proper basis and provided for at stated periods.

Unfortunately the qualifications of the city and town engineers of many of the smaller municipalities of the State are not upon any higher plane as evidenced by the fact that the writer found a city engineer of a small city of the State who had been retained by a certain interest to run some levels which any amateur ought to have been able to run accurately, but upon verification, it was found that the work exceeded an error of two feet per mile. In another city of like size the writer was called in a litigation wherein the city engineer of his own motion had changed the grades of several of the streets without authority and without notice to any one, with the idea that it would look better, forgetful or ignorant of the fact that such things should be accomplished only by a due process of law.

The question is, What is the remedy? A political writer of this country, now deceased many years, said "Foresight may come to individuals, but to assemblies never." In past years whenever the question of increased compensation for engineering work within this State has been broached to any General Assembly, its members have answered with a cry of "graft" and the fear of ire of their constituents. While the attorneys of the State are enabled to control the fixing of attorneys' fees, the engineers have uniformly met with stern refusals to consider any increase in their compensation. In Ohio the minimum per diem for public work has been fixed at five dollars per day. This was done only after the vigorous action on the part of the Ohio Engineering Society.

The time is ripe for our Society to take up and vigorously push this question. Under our statutes as to roads, drainage and levees, the per diem ought to be fixed at ten dollars and all necessary travel expenses and provision by law either for cash deposit or advance from the public funds for this compensation. The salaries of city engineers ought not be classified solely upon the basis of population of their respective cities, but in addition to the population, classification ought to be further based upon the volume of business transacted by the office and the value of improvements annually designed and supervised.

In return for these concessions for increase of compensation upon public works—whether city or county—engineers ought to be examined and registered by a State Board as to their professional qualifications and only such possessing the requirements to pass examination and registration be employed upon the public works of the State. Under the rates now fixed for these works, an ordinary coal miner receives more in wages than does the engineer of a fifty-thousand-dollar drainage project within this State.

The President recommends that this meeting of the Society adopt vigorous resolutions and urge its Committee on Legislation to place the same before the present General Assembly. It is only necessary to observe the ethics practiced by the attorneys of the State to readily grasp the situation that by concerted action, any profession may properly protect itself. It is certainly due the taxpayers of this State to be shown where their money is in many instances being wasted, and it is due from this Society to the inhabitants of the State that the abuse of the present system be exhibited in its true light; that the same be corrected and the tax payers' money be more intelligently and more economically expended upon public works.

*From the Presidential address at the Annual Meeting of the Indiana Engineering Society.
†Princeton, Indiana.

A Steam-Turbine Installation of 18,000 KW. total capacity (two of 3,000 KW. and two of 6,000 KW.) are supplied by eight 900-HP. water-tube boilers in the power station of the Hudson & Manhattan R. R. Co., Jersey City, N. J., operating the New York-New Jersey rapid-transit tunnels. The ultimate rated boiler capacity is intended to be 14,400 HP., but at present the half installation is being forced to meet the load. Formerly four engine-driven fans supplied air for forced draft at a pressure of about 2 in. of water. It was found necessary to dump the fires four times every 24 hrs. to avoid a deep bed of ashes on the grates. The engine-driven fans have recently been replaced by a single motor-driven blower (Sirocco type), 72 ins. in diameter by 72 ins. wide. Now a draft of 5 ins. is secured and it is necessary to dump each fire only three times in 24 hrs. The grade of coal is a No. 3 buckwheat anthracite; at peak load the consumption reaches 30 lbs. per sq. ft. of grate surface. The equipment was designed by Mr. L. B. Stillwell, M. Am. Inst. E. E., of New York City, and the fan was built by the American Blower Co., of Detroit, Mich.

Problems Involved in the Selection of Machinery for the Manufacture of Portland Cement.

By PAUL C. VAN ZANDT,* M. Am. Soc. M. E.

Portland cement is made by fusing limestone (or calcium carbonate) and clay (or iron and aluminum silicates) into a new substance having a definite chemical composition, and possessing new properties entirely different from its original components.

The raw materials, after being quarried, are crushed in rock crushers, dried in rotary dryers, accurately and intimately mixed in a definite proportion to produce the required chemical composition in the resulting cement, ground to the size of coarse sand (20 mesh) in ball mills or similar machines and then pulverized to the fineness of flour. This powdered material (100 mesh) is then burned in rotary kilns, and the resulting clinker is in turn ground, mixed with approximately 2% gypsum, pulverized and sacked for shipment.

It is necessary to mix intimately and accurately and to pulverize the raw materials very finely in order to make the fusion or chemical combination and avoid having any material left in the resulting cement in its uncombined state. The loss in burning is considerable, and there is some mechanical loss in dust from the stacks and other sources. The problem, therefore, is for every barrel of cement produced to reduce about 650 lbs. of raw material (containing some moisture) from the size it is received from the quarry to an almost impalpable powder, and of reducing about 400 lbs. of hard clinker from a size averaging, perhaps, ½-in. diameter to an equally fine powder. In a plant producing 3,000 barrels of cement per day, this becomes 2,000,000 lbs., or 1,000 tons of raw material, and 1,200,000 lbs., or 600 tons of clinker in every 24 hours for seven days a week and about fifty weeks a year.

The fuel used to burn the cement is usually pulverized coal and, at 100 lbs. of coal per barrel of cement, the coal amounts to 150 tons more of material to be powdered, or a total of 1,750 tons per day to be pulverized to approximately the fineness of flour. The power consumption is very high and averages close to 24 brake HP. hours per barrel of cement produced.

In addition to the above problems, the commercial one is that cement must be produced so cheaply that it may be sold for 65 cts. to 85 cts. a barrel, sacked and loaded on cars at the mill.

The raw materials consist, as stated before, of two substances, one limestone or $CaCO_3$, and the other clay or shale. The latter ingredient, if shale, is usually quarried and mixed with the limestone before entering the crusher. If clay, it is shredded in a clay disintegrator, dried and mixed with the limestone.

*First National Bank Building, Chicago, Ill.

The limestone or $CaCO_3$ may, however, exist in several forms such as marble, calcite, fossiliferous limestone from ocean deposits of shells, hard blue limestone of stratified formation, soft white limestone, chalk and marl. Soft chalk is usually cut out of the deposit by a steam shovel and crushed in spiked rolls or dry pans and is handled in the remainder of the plant in the same manner as the hard rock. Since marl is little used today, and does not require crushing or grinding, this article will describe the other forms of calcium carbonate.

Quarry Machinery and Crushers.

Small quarries are worked by hand, the large pieces of rock left from a blast being broken by men with sledges or drilled by hand and broken with small charges of dynamite. The rock is loaded into cars by hand.

This method of quarrying is much more expensive than steam shovel loading. Frequently two men will spend an hour's time on one piece of rock one yard cube in breaking it down.

The essential consideration in the selection of a stone crusher for a cement plant is seldom the capacity required, but the size of the receiving opening. For a hand operated quarry a No. 8 crusher is the largest there is any advantage in installing, and frequently a No. 7½ or even No. 6 is amply large when the rock ledges are thin and the rock breaks up in pieces 8 to 12 ins. thick.

Large quarries are operated most economically by loading into large cars by steam shovels, eliminating a large amount of hand labor and cost of haulage. The large cars may be as high as desirable to carry and dump the rock to the best advantage, and are usually side dump.

The selection of a crusher for a steam shovel quarry resolves itself to getting one with a receiving opening large enough to take the maximum size rock that the steam shovel can load and the cars can bring. This accounts for the demand for the largest gyratory crushers built, namely, the No. 18 with two openings, 36 × 97 ins., the No. 21 with two openings, 42 × 108 ins., and the No. 24 with two openings, 48 × 120 ins. Even these openings are none too large since the increase in the size of steam shovels built has been as great as in the crusher. However, very few pieces of rock come to a machine of this size in a day that are too big for it, and the few may be readily split in two with a light blast.

DIVISIONS OF CRUSHING.—Rock cannot be pulverized from quarry run to 100 mesh in a single machine or in a single operation. The best practice has divided it into three operations in three different types of machine, viz.; crushing, grinding and pulverizing.

It is practicable to crush from quarry size to about 2-in. or 2½-in. size in crushers. Where crushing rolls are used, the limit of fineness in economical operation is about ½ in. Rolls are really crushing machinery, but the work they do overlaps that done by grinding machinery; or, more accurately, grinding machinery has been developed which will overlap the crushing machinery in the size of the rock it will take, so that it is possible to eliminate rolls from a plant where this type of grinding machinery is installed. Rolls do not produce the proportion of fines that other crushers do. They have a valuable use when the rock is "spally" or "slabby." To break spalls and slabs, a corrugated face roll has been developed that will pass through any cubical piece of rock to 2½-ins. diameter, but will nip and break any spall thicker than ¾ in.

Rolls are good recrushers for rock 2½ ins. and smaller, as they require very little attention to do their work well, nipping only the big rock going through, letting rock already small enough pass through, and requiring no attendance to feed them.

The practical limits of grinding are from 2 ins. or 2½ ins. down to 20 mesh, and of pulverizing from 20 mesh down to 200 mesh and finer.

A 20-mesh screen is one having 20 wires to the inch running in both directions, so as to produce 400 openings to the square inch. Since the wire is approximately of a diameter equal to the width of each opening, the wires are about 1/40 in. in diameter and the openings 1/40 in. square. In the same way a 100-mesh or a 200-mesh screen is a screen having 100 or 200 wires to the linear inch running both ways and having 10,000 or 40,000 square openings to the square inch, approximating 1/200 in. square or 1/400 in. square.

A fact not to be overlooked in considering material of a given mesh is that when rock is crushed to a given size, for example, all through 20 mesh, as a matter of fact about 45% will pass 100 mesh, 60% through 50 mesh, 80% to 85% through 30 mesh. The real definition of 20-mesh material would, therefore, be a material composed of particles of different sizes, ranging from infinitesimal up to the size of the openings in a 20-mesh screen.

This is a correct definition for 20-mesh material, but a similar one would be incorrect for 100 or 200-mesh material, as it is almost impossible to produce material in any grinding or pulverizing machine all of which will pass a 100 or 200-mesh screen, and, as a matter of fact, it is impracticable to attempt it. If an attempt should be made in any of the grinding machines in use in cement plants to-day to grind the cement so that all would pass a 100-mesh screen, the result of the attempt would probably show 99% passing through a 100-mesh screen, 98% through the 200, and, perhaps, over 90% fine enough to pass a 500-mesh screen, if such a screen were possible. This shows how much unnecessary work would have to be done upon all of the material just for the sake of getting a few of the

FIG. 1. VIEW SHOWING SIZE OF ROCKS BEING LOADED BY STEAM SHOVEL IN A CEMENT QUARRY, DIXIE PORTLAND CEMENT CO.

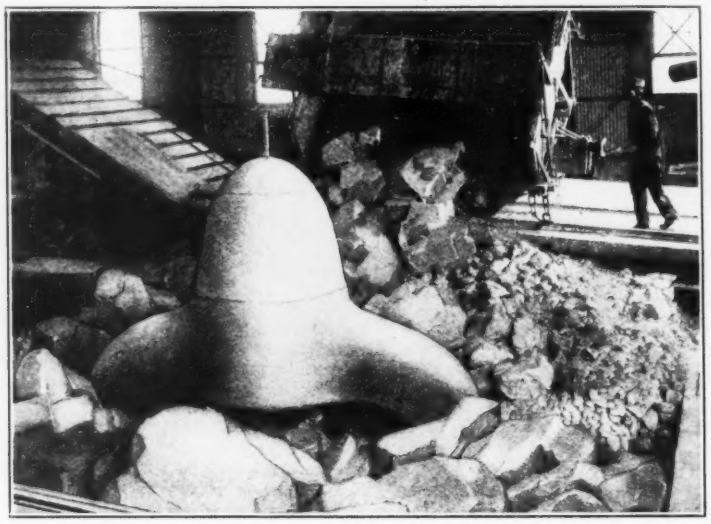

FIG. 2. TOP OF NO. 18 GYRATORY ROCK CRUSHER AT MICHIGAN ALKALI COMPANY'S QUARRY FURNISHING ROCK FOR HURON PORTLAND CEMENT CO.

largest particles fine enough to pass these exceedingly fine meshes.

To give an idea of the proportionate amount of work done in each one of the three divisions of crushing and grinding mentioned above, the following is an estimate of the number of pieces one cubic foot of rock is divided into in the different departments, together with the amount of horsepower hours required per ton of rock crushed in each department.

The crushing department reduces the rock from one piece to approximately 250 pieces (from 1-ft. cube to 2-in. cube). To do this work, approximately 1-HP. hr. is used per ton of material crushed.

The grinding department reduces the rock from 250 pieces to approximately 16 million pieces (from 2-in. cube to 20 mesh). To do this work, approximately 8-HP. hrs. are used per ton of material ground.

The pulverizing department reduces the 16 million pieces to exceeding 20,000 million pieces (from 20 mesh to 85% through 200 mesh.) To do this work, approximately 16-HP. hrs. are used per ton of material pulverized.

It is easy to see from the above that the reduction from 20 mesh to 200 mesh involves by far the greatest amount of work.

DRYING MACHINERY.—It is impossible to grind and pulverize a rock to 100 mesh without drying it so as to contain less than 1% moisture. As it almost never occurs in nature as dry as that, every cement and similar grinding plant must have drying equipment.

The essential requirements of a machine to dry cement rock are that it must heat the rock to a temperature in excess of 212° F., and hold it at this temperature for the required length of time to give up its moisture in the presence of moving gases, which are able to absorb or carry away the moisture given off and not redeposit it before leaving the machine. This is best accomplished in the rotary dryer. The machine is a cylinder of steel, approximately ten times as long as its diameter, set with its axis slightly inclined from the horizontal, and revolving at a speed of 2 or 3 revolutions per minute. The rock to be dried is fed in at the upper end by a spout passing through the smoke chamber into the end of the machine and gradually rolls to and out the opposite end of the machine against the ascending current of hot gases and products of combustion which pass through the dryer from the fire at the discharge end.

The commonest error in the design and operating of dryers is to fail to permit sufficient air to pass through to carry away the moisture. Another common error is to increase the speed to secure greater capacity. This really has the reverse effect, as the material is subjected to the heat a shorter length of time. Plenty of lifters should be put in to shower the material through the current of gases and air. The fuel consumption of the ordinary dryer varies, of course, depending upon the percentage of moisture in the material to be dried and the thoroughness with which the material is dried; but for thorough drying, can be roughly placed at an evaporation of from 4 to 7 lbs. of moisture per pound of coal burned. The amount of fuel used can be made as low as 1 lb. coal to 20 lbs. moisture under some conditions; but this is not commercially possible in ordinary cement-plant operation.

Grinding and Pulverizing Machinery.

Ball mills and tube mills are specially adapted to the fine pulverization of dry raw materials, the latter serving simultaneously as an excellent mixer. These two machines are used both for preparing the raw material and for grinding the clinker into the finished cement. It is usually safe to estimate that the same number of these machines as are necessary to pulverize a given quantity of clinker to finished cement will be required for preparing the raw material.

Ball mills were originally made to produce, from very coarse material, a finely finished product in a single operation. After certain limits were reached, this resulted in a marked reduction of capacity, and the machine is, consequently, used nowadays to produce not finer than 20-mesh product.

A charge of 3½-in., 4-in. and 5-in. forged steel balls in the ball mill usually constitute the initial charge, one-third of each by weight. In use, usually the 5-in. are added to replace the wear, the grinding action of the mill producing the necessary smaller ones to partially fill the interspaces.

The tumbling of the balls and material, due to revolving the drum rapidly, reduces the material to fine grit and powder, steps in the mill serving to greatly increase the beating action of the balls against the material.

When partially reduced, the ground product falls through apertures in the wearing plates to the first screen. The rejections from this screen are promptly returned to the mill through the openings between the overlapping plates, while the fines go to the outside finishing screen, and that which passes through falls into the dustproof housing and is removed by a conveyor or other means for final pulverization. The residues join those of the other screen, and with them are returned to the mill and subjected to a further grinding action of the balls until they are fine enough to pass the outside or finishing screen.

In practically all cement plants it is now found advantageous to finish the preparation of the raw material for the rotary kiln in tube mills in preference to any other form of grinder. Some plants have endeavored to do the grinding and mixing with other forms of grinding machinery, and have failed to a greater or less degree. In practically all the new installations in the West, if not throughout the United States, where the raw material is limestone and clay or shale, or, in other words, two separate materials, which have to be mixed, tube mills are being used for the fine grinding and mixing of these materials, preparatory to burning. There is no better mixer than the tube mill.

Upon the clinker end, the tube mill is considered the best machine for finishing the clinker into cement, and is of great assistance to a plant in making the product uniform and free from streaks of cement of varying fineness.

Portland cement clinker should first be reduced to at least 20 mesh, or finer in a ball mill and finished to the market fineness, which is at least 92% through 100-mesh laboratory sieve, in tube mills. The modern requirements for fineness of grinding cement are becoming more and more severe, and specifications are beginning to include the amount of cement which must pass a 200-mesh screen. Cement pulverized in ball mills and tube mills usually contains a higher percentage of very finely ground cement passing a 200-mesh sieve than that produced by any other process, and as this fine material adds greatly to the sand-carrying capacity of cement, it increases likewise its real value.

The tube mill consists of a steel plate cylinder, provided with driving gear. At the ends it is closed by heavily reinforced cast-iron heads, which have at their centers hollow trunnions through which the material is fed in at one end and discharged at the other.

In operation, the mill is filled to a point a little below its axis with material to be ground and pebbles and made to revolve, causing the mass of pebbles and material to tumble over each other with a wavelike motion, developing in this way an enormous grinding surface capable of reducing material to any desired degree of fineness, and this without screening. The slow speed at which the machine revolves makes its use especially desirable in the dutsy atmosphere found in cement plants.

The machine that has been most used in the past is the 5 × 22 ft. mill; however, the 6 × 22 ft. is now very commonly used with excellent results, and both 7-ft. and 8-ft. mills are now being tried out in a number of plants.

The 5 × 22 ft. machine, receiving a properly prepared feed of average Portland cement clinker, will pulverize from 14 to 20 barrels per hour, the quantity varying with the hardness, age and fineness of the clinker. This mill requires from 70 to 75-HP. to operate it, and about 125 HP. momentarily for starting.

The wearing surfaces in the tube mill are hard plates of iron or steel, as the case in machines previously mentioned, or are made of stone. The shell of the mill is usually lined with a hard flint, known as silex. Bricks of silex are grouted in with Portland cement. The pebbles used are also hard flint, and there are 70,000 to 100,000 in a 6 × 22 ft. tube mill.

The tube mill will do the work required of it for less cost than any other machine. It is remarkably free from breakage and trouble of any kind. The wearing parts are cheap and easy to put in place. The wear and tear is very light, the depreciation an absolute minimum, while, so far as attendance is concerned, the mill runs itself, and all the attendant has to do is to watch and oil it. It possesses the remarkable ability of being able to produce a product 100 mesh and finer without the use of screens, and will produce an absolutely uniform product so long as the feed is constant. It takes approximately 16 HP. hrs. per ton of rock ground, or about 5 HP. hrs. per barrel of cement.

Rotary Kilns.

By far the most interesting machine in a cement plant is the rotary kiln. This machine is a cylinder of steel, usually about 8 ft. in diameter by 125 ft. long, set nearly horizontal, but sloping slightly from the feed end, or the end where the material enters, to the discharge end. It is provided with two tires encircling the shell, one near each end, and a girth gear driven from a train of gearing underneath so that it may be rotated. The tires are supported upon rollers.

The inside of the shell is lined with fire brick. The pulverized raw material is delivered to the upper end. The rotation of the kiln, together with the slight pitch, causes the material to roll slowly to the discharge end. The length of time required for the material to pass through the kiln varies from 3 to 6 hours. At the discharge end of the kiln the fuel, either coal, gas or oil, is blown in through a hole in the hood closing this end, and burns with a long, intense flame, heating this end of the machine to a temperature approximately 3,000° F.

In the first 10 to 25 ft. of the upper end of the kiln, what moisture remains in the material, which is very seldom over ½%, is driven off, and the material is heated to approximately 1,000° F. At this temperature, the carbonic acid gas contained in the limestone is given off very rapidly, but since a very large proportion of the heat put into the kiln is required to do this work, the temperature of the material does not increase very much for the next 40 or 50 ft., the time required for the material to pass through this distance representing the time required for it to give up its carbonic acid gas. The mixture now consists, of clay and unslaked lime, CaO. After the carbonic acid gas is driven off, the material is gradually heated in the next 30 or 40 ft. of the kiln to a temperature averaging 2,500° F. By this time it has reached within 10 to 20 ft. of the discharge end, and anyone looking into the discharge end with a pair of smoked glasses can see very plainly the burning of the material into cement clinker. When the material has been heated to the temperature required to effect the chemical combination, it begins to emit short greenish flames; in other words, it actually appears to be burning. Further back in the kiln, the material is black and has begun to ball up into little pieces, from the size of peas to the size of large marbles. The burning action takes place in two or three feet of the length of the kiln, and the burning zone can, therefore, be very accurately located. Just as the material leaves the burning zone it suddenly becomes incandescent or white hot. The reason for this is that there is a slight amount of heat given off by the material when the chemical combination takes place.

The duty of the burner operating the kiln is to keep the temperature of the clinker as low as possible and still effect this combination perfectly. As soon as this condition has been brought about, the work upon the clinker is done, and it soon rolls out of the kiln. The burning zone is kept back from the firing end of the kiln about 10 to 15 ft., in order that the operator may have some control of the machine. If the feed is too heavy for the amount of fuel being burned, this

burning zone gradually creeps towards the discharge end. Should the burning zone reach the discharge end underburned, bad clinker would leave the kiln. Before this happens, therefore, the operator supplies the machine with more fuel or else slows it down or, if necessary, even stops it, maintaining an intense fire until the burning zone is driven back to a point where there is no danger of underburned clinker leaving the kiln. If it is driven back too far, or the kiln gets too hot, he stops the supply of coal for a short time or cuts it down, as there is danger of burning out the lining of fire brick, which is nearly white-hot on its inner surface at this point in the kiln, and which is covered with a thin coating consisting of partly fused clinker and partly fused fire brick.

So long as this coating or skin can be kept on the inner surface of the fire-brick lining, it protects the lining proper from being burned out and also from abrasion.

Rotary kilns are of comparatively recent invention, the first one being put into practical use approximately 15 years ago. The first rotary kilns were 5 ft. in diameter by about 40 ft. long, and for several years the standard kiln was 6 × 60 ft. About six years ago there was a sudden change in the industry, and the tendency since that time has been to put in larger and larger machines. The standard for the past two or three years has been 8 × 125 ft., although kilns have been installed as large in diameter as 12 ft., and as long as 230 ft.

A kiln, 10 × 175 ft., is approximately the limit of size that can be mounted on two tires, and approximately the limit of perfect mechanical operation. Any shell mounted on more than two tires gives trouble, as the heat warps the kiln and it will not bear on all the rollers evenly, putting enormous strains onto the shell. Any larger diameter than 8 ft. does not give any greater fuel economy, as a great deal of heat escapes through the center of the kiln without doing any work. It is also necessary to make the lining thicker, so that it will not fall out, which decreases in turn the internal diameter. The abrasion on the lining is also greater on account of the greater distance the material has to travel.

It is interesting to note that ten years ago the designers and builders of cement plants were in the habit of making specifications for the machinery they desired and submitting them to the manufacturers of machinery. Immediately upon lengthening and increasing the diameter of the kiln, this procedure was reversed. The manufacturer of the machinery has become the designer and the user has accepted what he has designed. There never was a standard kiln, hardly any two being built alike, until the manufacturer took the design into his own hands. Now there are very few kilns being built that are not standard.

FUEL.—An interesting point in connection with the rotary kiln is the thermal efficiency. The little kilns burn from 120 to 225 lbs. of coal for every 380 lbs. of cement made. A modern large kiln burns from 90 to 100 lbs. of coal to accomplish the same result. The thermal efficiency is really very good, considering the crudeness of the machine and the inability to effect any great saving of waste gases. The basis of all the figures given below is a coal possessing 13,400 B. T. U. to the pound, and 100 lbs. coal being required to burn a barrel of cement. This heat is used as follows:

HEAT ANALYSIS OF COAL USED IN BURNING ONE BARREL OF PORTLAND CEMENT.

TOTAL HEAT.

100 lbs. coal used to burn one barrel (at 13,400 B.T.U. per lb.)	1,340,000 B.T.U.

HEAT USED IN COMBUSTION.

	Per Cent. of total.
Heat consumed by products of combustion, 398,600 B.T.U.	29.70
Heat consumed by 50% excess air in kiln, 201,400 B.T.U.	15.30
Total	45.00

HEAT USED IN BURNING CEMENT.

12 lbs. water evaporated and heated to 1,500° F., 20,832 B.T.U.	1.56
600 lbs. mix heated to approximately 1,000° F., 112,800 B.T.U.	8.40
450 lbs. limestone decomposed and CO_2 driven off, 344,250 B.T.U.	25.60
204 lbs. gases (liberated from mix) heated to 1,500° F., 24,480 B.T.U.	1.83
384 lbs. mix heated to approximately 2,500° F., 115,200 B.T.U.	8.60
6 lbs. sulphur anhydride liberated at 1,900° F., 11,340 B.T.U.	.85
Unaccounted for (assumed lost in radiation) 111,098 B.T.U.	8.16
Total	55.00

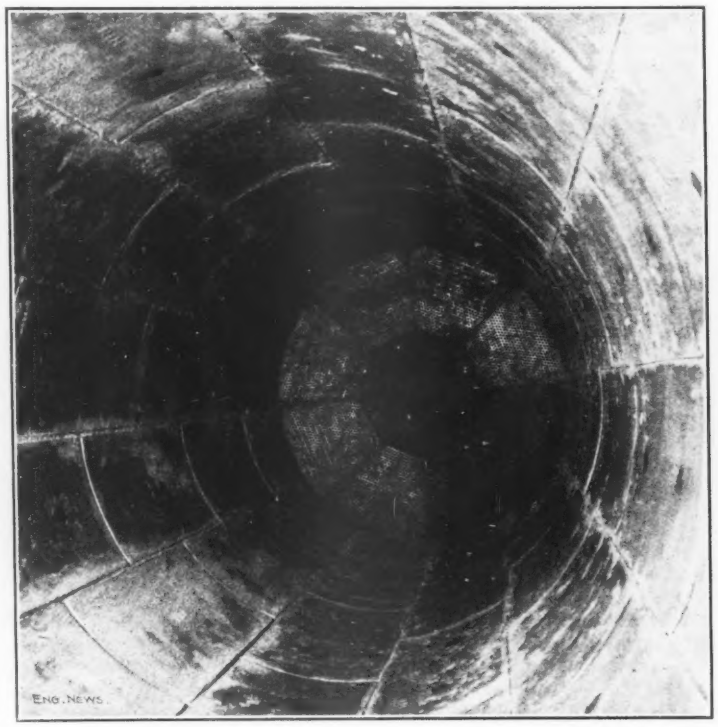

FIG. 3. INTERIOR OF ALLIS-CHALMERS TUBE MILL LOOKING TOWARD DISCHARGE END, SHOWING LINING PLATES.

HEAT LOST (Available for recovery).

Going up stack (figuring gases at 1,500° F.)	49.90%	(Approx.)
Going out with clinker (2,500° F. down to 60° F.)	14.19%	(Approx.)
Radiation from shell (by subtraction)	8.16%	(Approx.)
Total	72.25%	
This gives an approximate total thermal efficiency of	27.75%	

The 55% of the total heat in one hundred pounds of coal used in burning a barrel of cement may be analyzed as follows, showing where the heat goes that is actually used in burning the cement and not used in heating the products of combustion themselves:

Driving off moisture	2.35%	(Approx.)
Driving off CO_2 (and SO_3)	46.58%	"
Heating gases driven off	8.92%	"
Heating mix	27.35%	"
Radiation of heat	14.80%	"
Total	100.00%	

It is the impression of almost every uninitiated man that a great deal of the heat lost in the rotary kiln could be easily recovered, and a great many schemes have been tried to recover this heat, but they all possess a very great disadvantage in that they hamper the kiln in its function of producing Portland cement clinker. The primary object of the kiln is to produce clinker and not to produce waste heat to be saved, and anything that hampers the kiln in this function is of necessity an ultimate detriment to the plant.

A most common mistake made in endeavoring to save the waste heat from a kiln is to assume that the heat going up the stack may be saved by *burning the gases* under a boiler or a dryer. The gases leaving a rotary kiln are absolutely inert. They possess a large amount of carbon dioxide gas, very little oxygen, and no other burnable gas. In other words, there is no carbon monoxide gas or hydrogen, as there is in the gas of a blast furnace.

The only heat these gases would give up is the heat contained in them on account of their high temperature, and this cannot be augmented by an auxiliary fire under the apparatus in which this waste heat is used, as these gases will put out any flame in which they come in contact. This is a great drawback to using these waste gases. The dust in the gases make the use of any but vertical tube boilers impossible on account of the dust getting on the flat surfaces and acting as an insulating medium, preventing the heat from reaching the water. Passing the waste gases through auxiliary apparatus materially interferes with the draft. The only apparatus the writer knows of that could be used successfully for waste heat saving would be a Green Economizer, but he knows of only one installation where this particular machine has ever been used.

Waste heat is given off by the white-hot clinker leaving the kiln, and a number of schemes have been devised to use it. The best and practically the only successful scheme has been to use it to heat the air blown into the kiln with the coal, and this is done best by dropping the clinker into a concrete box immediately under the kiln and putting the suction pipe to the blower into this box to draw its supply of air. This, however, possesses one disadvantage in that a certain amount of fine clinker dust is picked up and carried through the fan and the coal ejector, which wears out both of these very rapidly.

COOLING.—Clinker should be cooled after leaving the rotary kiln, usually because of the necessity of handling the material at once in conveying and grinding machinery, which would be injured by the red-hot material. Another reason for cooling is that cooled clinker seems to grind a little easier. It is usual to spray the clinker with a stream of water where the arrangement of the machinery is such that this can be done without detriment to the operation of the kilns. This water, striking the red-hot clinker, shatters it to a certain extent, which makes it very much easier to grind. If not too much water is added it will be evaporated before the clinker reaches the grinding machinery, so that it does not require redrying.

The best form of cooler in use at the present time is the rotary cooler, which is similar to the rotary dryer, except that it is not provided with any fire-box, and when arranged under the kilns it is also frequently without a stack; otherwise it is provided with a stack, which creates a draft through the cooler, drawing cool air into the lower end, which gradually becomes heated in contact with the clinker and extracts the heat from this material. When the cooler is arranged under the kiln the stack draft of the kiln automatically provides a draft of cool air through the cooler, which, after being heated by contact with the clinker, enters the kiln at a higher temperature than would be the case were the air drawn into the kiln from the room.

STORAGE.—Most plants provide for a clinker storage pile. In a 3,000-barrel plant a good clinker storage pile would hold about 100,000 barrels, which will be sufficient to store the clinker for 30 days. This, in the writer's opinion, should be out of doors, exposed to the elements, which assist in disintegrating the clinker and making it more easily ground, and in slaking any free lime which might exist in the clinker, so that the boiling pats in the aged clinker will be sound.

The strongest cements are those that are burned with the greatest amount of lime in the mix, but the slightest excess of lime in the mix will result in an unsound cement; consequently, the advantage of storage in a plant where a high lime

mix is burned is apparent, for should any of the cement be slightly unsound on account of slight excess of lime, this aging will render it a perfectly sound and good cement. In many cement plants clinker, hot from the kilns, will frequently be found unsound on account of this excess of lime but cement ground from clinker taken from a storage pile thirty days later will be perfectly good.

The grinding of Portland cement is a duplication, to all effects and purposes, of the grinding operation going on in the raw side of the cement plant, the same machinery almost invariably being used. At some point after leaving the kilns the clinker must be weighed for the purpose of adding gypsum to it; about 2% of gypsum is usually added. Portland cement without any gypsum in it usually sets too quickly for contractors' work, and hence the gypsum is added to slow the rate of setting. This is usually done by "dosing" a weigh hopper full of clinker with the proper quantity of gypsum measured out in a box.

When the gypsum is moist it sometimes coats the pebbles in the tube mills, sticking to them and to the lining of the tube mill, thereby reducing the efficiency of the mill. Where this is the case, and a different form of gypsum cannot be added which will eliminate this trouble, the ball mill should be provided, with coarse screens, delivering a coarse feed to the tube mills, which is permitted to go through the machines fast enough so that the resulting product from the tube mills will be coarse.

This is then put over a Newaygo shaking screen and the finished cement sent to the stock house, while the coarse rejections from the screen are returned to the tube mill. The reason why this method of operation eliminates this trouble is that the coarse material in the tube mill cleans the coating from the pebbles and lining, which fine material will not do.

FUEL.—The fuel burned in the rotary kiln, as stated before, is either natural gas, oil or coal; natural gas and oil are blown in by air, the oil being heated in a steam coil and atomized in a burner. Coal, however, before it can be used in a rotary kiln, must be dried and ground to a fineness of approximately 96% through 100 mesh. To accomplish this, a rotary dryer is usually employed, similar in construction to the rotary dryer described for the raw side, the only difference being that the fire is usually built in a fire-box under the middle of the shell. This warms the outside of the shell first, and the gases from the fire, when they have become partly cooled, are permitted to enter the lower end of the dryer through a "by-pass," and go through the inside of the dryer to a stack at the upper end in the regular manner. The direct heat from the flame of the fire would be sufficient to warp the dryer shell if it were stopped any time; so a fire-brick arch is put in directly over the fire-box, and this arch protects the shell and conveys the products of combustion to one side of the fire before they are permitted to strike and encircle the shell from the outside.

Slack coal is usually used when it can be obtained, but some plants have to use run-of-mine, in which case the large lumps are cracked in a set of spiked rolls before drying. In either case, the coal is ground in a set of disintegrating rolls and fed to a tube mill. The pulverized coal leaving the tube mill is conveyed to a tank in front of each rotary kiln, usually holding 6, 8 or 10 hours' supply for the kiln. It is drawn out of this tank or hopper by a small screw conveyor at a regulate rate and dropped into an ejector, where it is picked up by a blast of air blown into the kiln, in which it burns the same as gas.

MIX.—Where possible to do so, an accurate mix of limestone and shale should be made before the materials are delivered to the crusher, so that the proper cement mix begins at the crusher and follows all the way through the plant.

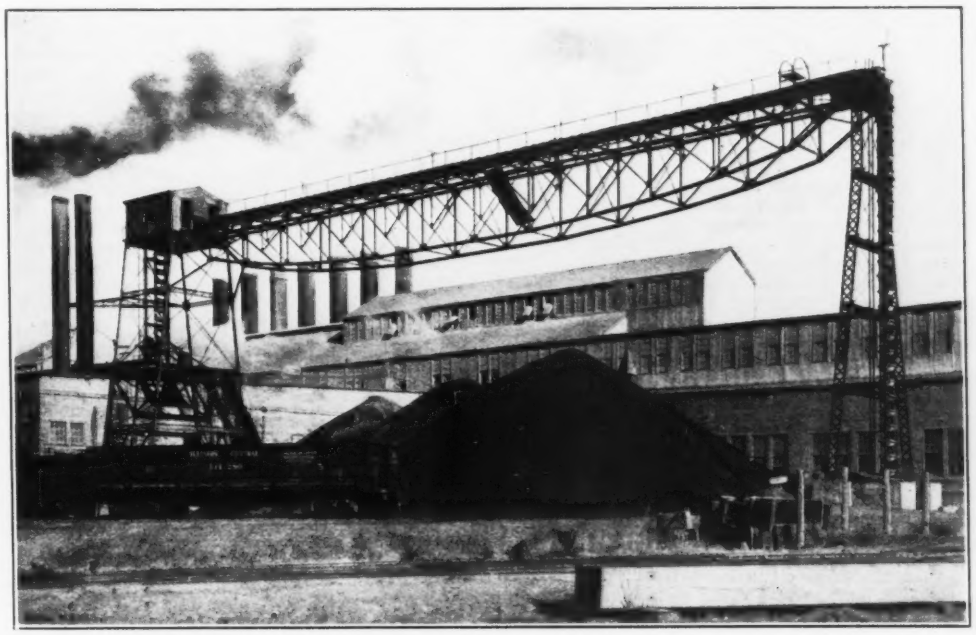

FIG. 4. CONVEYING CEMENT CLINKER TO STORAGE. WORKS OF CHICAGO PORTLAND CEMENT CO., OGLESBY, ILL. PECK CARRIER; HEIGHT, 70 FT., SPAN 160 FT.

(Reproduced from booklet issued by Chicago Portland Cement Co.)

Where it is impossible to do this easily, the best place to make a mix is with the dry materials after they have passed the ball mills. This is frequently necessary where clay is used, as some other machine besides a ball mill may be used for the pulverizing of clay. Both materials are then crushed to about the size of meal or sand, and can be accurately weighed in either hand-operated or automatic scales and accurately mixed before reaching the tube mills.

Where dry clay and lime rock are used in the manufacture of cement and mixed before going to the ball mills, it frequently happens that the material segregates in the bins. The clay, which is usually the finer of the two materials, drops in the center of the bin in a solid mass, and the lime rock, especially the larger pieces, rolls to the outside of the bin. Then, when the materials are drawn from the bin, it usually "pipes" down the center, feeding out all the clay first and allowing the lime rock to follow. This is very confusing to the chemist endeavoring to control the mix, and should be avoided wherever possible.

Newaygo screens or similar screens are frequently used between the ball mills and tube mills, and where the two materials are mixed before going to the ball mills, these screens have a certain tendency to screen out the clay, which is the easier ground, returning the limestone, which is the harder ground, to the ball mill, making a slight segregation in this way. The result is that the clay added to any batch of lime rock passes on ahead of the lime rock to which it is added, and becomes associated with the lime rock which went into the plant prior to the addition of this particular batch of clay.

If the mix is perfectly uniform from day to day, and the operation of the plant is continuous, this makes very little difference; but it delays the correction of an incorrect mix, especially where the mix is running low in lime, and is more or less confusing to the chemist, who has to wait a longer time to determine the effect of a correction than in the case stated above, where the two materials are mixed after having passed the ball mill.

Selection of Machinery.

In the selection of dryers for large plants, 3,000 barrels or over, dryers approximately 6 ft. in diameter by 60 ft. long seem to be the best size. They require from 10 to 15 HP., and are large enough for any ordinary plant. A simple method of calculating the capacity of a dryer, and one that is ample for ordinary rough calculations, is to multiply the diameter in feet by the length in feet by 10, the resulting product representing the number of pounds of moisture which the dryer will drive off in an hour from a material containing not less than 6% moisture, drying down to about 1%. For example, a 6 × 60 ft. dryer will dry six times 60 times 10, equals 3,600 lbs. of moisture per hour. If a lime rock carries 6% moisture, this 3,600 lbs. represents 6% of the total of approximately 38,300 lbs. wet lime rock per hour. The dryer would produce about 35,000 lbs. dried lime rock per hour.

Ball mills and tube mills are usually arranged in one room called the grinding room. Where the plant is small, raw grinding and clinker grinding are done in the same room, which has the great advantage of enabling one set of attendants to handle both departments. Where the plant is large and two sets of attendants would be required, anyhow, two grinding rooms or buildings are provided—raw grinding and clinker grinding.

The best arrangement is one with the bins down the center of the building in a double row, one side for the ball mills and the other side for the tube mills. The motors driving the ball mills are located in a separate building or lean-to outside of the grinding room proper on the ball mill side. The tube mill motors are located in a similar lean-to on the tube mill side. This keeps the electrical machinery out of the dusty grinding room. The countershafts of the machines should extend through the wall, the belts and driving pulleys being in the motor room, where they do not accumulate dust, which is a frequent cause of belt slippage in a cement plant. In selecting the size of grinding machinery, the writer's opinion is that the larger the units, provided there are two or more in any given plant, the more cheaply they will produce ground raw materials and ground cement. For example, a No. 9 ball mill is preferable to a No. 7 having approximately twice the capacity with approximately the same attendance, the same amount of auxiliary machinery, very little more foundations and buildings to cover it, and is much cheaper in first cost, as well as operating expense per barrel of cement produced.

The storage bins in back of the kilns should be very large, if possible, large enough to hold a day's storage. The raw grinding and clinker grinding departments should be of greater capacity than the kilns, so that the kilns can be kept going all the time. If a plant is properly balanced the bins in back of the kilns are always kept full of raw material. It also has the additional advantage of giving the chemist considerably more leeway in event of having to send through the plant a correcting or neutralizing mix, as he will be able to catch the mix in error with his correcting mix before it has reached the kilns.

In relation to power, it requires from 15 to 20 KW. hrs. on the switchboard of the power plant per barrel of cement produced in a cement plant. Consequently, even a small cement plant can afford to have an economical power plant, considering the amount of power necessarily developed. The most modern power plants consist of

high-pressure steam turbines, usually generating electric current 440 volts, 60-cycle, 3-phase, which is used in induction motors for individual drives to each of the heavy machines, and group drives for such machines as elevators and conveyors.

In selecting the motors, the small motors should all be made of one size, preferably about 10-HP. in most cement plants. In small plants the small motors may be 7½'s and in large ones 15's. There should be as few different sizes as possible.

A typical cement plant installation are motors of 10 HP., 20 HP., 50 HP., 100 HP., and 150 HP., with no intermediate sizes. A spare 10-HP., 50-HP and 150-HP. motor are kept in stock, so that no single motor could burn out in the plant anywhere but what one of these spare motors could be immediately applied to its work.

The large motors for driving crushers, ball mills, tube mills and kilns are preferably made special for the cement plant work, with high starting torque in proportion to the amount of starting current required, large air gap, to avoid filling up with cement dust, large frame size to take care of the extra heating caused by the lack of ventilation when the ventilating ducts in the motor are filled with cement dust, and of heavy duty or mill construction, in order that they may run 24 hours a day and 30 days a month without shutdown.

The large motors in a cement plant may be either belted or direct geared to the heavy machinery. When direct geared the motor should be separated from the shafting by a flexible coupling. Long, heavy line shafts, with one very large motor, driving a group of grinding machines, should be avoided, as should also the use of friction clutches.

Some attention, in the design of a cement plant, should be paid to the location of the plant geographically. Plants in the Lehigh Valley, all of which operate on very similar materials, should have proper attention paid to the installations in other plants in that vicinity, as operators or attendants are accustomed to the methods employed in existing plants, and a radical departure from their general design, unless resulting in an essential saving, will only make it more difficult for the attendants to properly run the plant. In the South, where negro and Mexican labor is frequently employed, the designer should be careful that everything possible be made "foolproof," even more so than in the North, where the class of labor is more intelligent.

Considerable attention should be paid to standardization of parts, as everything in a cement plant rapidly wears out and must be quickly repaired, and a considerable stock of repair parts has to be carried on hand. All elevators, for example, should be identical, so far as head, boot, chain, buckets, etc., are concerned, and different only in their length. All conveyors should be exactly alike in the same way. Screw conveyors should be made only in standard lengths, namely, 12 ft., for anything over a 10-in. conveyor. Screw conveyors should be made very heavy, at least XX. A 2,000-barrel cement plant or less will operate nicely on a 12-in. XX screw conveyor throughout the plant. A cement plant, 3,000 barrels or larger, should have 16-in. screw conveyor, with ¼-in. or even ⅜-in. flights. All gears, pinions, countershafts, bearings, belts, and pulleys, sprockets and chain, throughout the cement plant, should be reduced to the fewest possible types and sizes, so that one pinion or one bearing or one pulley fits in as many different places as possible.

In calculating the sizes of any of these parts, it should be borne in mind that making cement is very heavy work, and the strains that come upon all the machinery in actual practice are, as a general rule, very much heavier than would be assumed by a theoretical engineer in calculating what ought to come upon the machinery. A chain will catch and ride on a sprocket tooth, putting exceptional strains on a countershaft and bearings; an elevator will clog, a kiln will have a ring on one side, which has to be elevated in the rotation of the shell; a belt will get dust between it and the surface of the pulley, causing it to slip, etc. The writer has heard several prominent engineers in this industry make the statement that after a theoretical calculation of the size of a part has been made for a cement plant, they multiply the result by two in determining the size of the part to be put in, and in some cases even this is not sufficient.

Should the Government Lease Its Coal Deposits or Sell Them Outright?*

By GEORGE OTIS SMITH.†

West of the one hundredth meridian lies the Nation's greatest coal reserve estimated at more than a million million tons of anthracite, bituminous and sub-bituminous coal, and from 60 to 85% of this tonnage is owned by the United States. This fuel reserve is the key to the present and future development of the Rocky Mountain region.

The West needs and has a right to demand full opportunity for development, but that does not include the right to inflict an unearned speculative tax on the future consumer. The coal operator may justly ask two things—first, the right to occupy an area sufficiently large for economic operation, and, second, freedom from too great investment risks. The public should also demand that no right to the public coal land shall be granted except for present use. Actual development must be made the first condition of occupancy of any part of what now remains of the public domain.

Is Our Coal Law Adequate?

The large holdings of coal land in the West legitimately acquired through railroad grants, by coal companies through dummy entrymen, and by purchase of agricultural entries as well as those patented to the States as non-mineral lands, together constitute a supply of coal land that has practically met the demand. Up to the present time the acquisition of the coal land in the public domain has been largely accomplished without recourse to the coal-land law, so that the question becomes opportune. Is the present coal-land law adequate to met present and future needs?

This law, by its provision for the valuation of coal lands at an adequate price, makes possible a selling price that may promote development and at the same time prevent monopolization and discourage speculative holding. The purchaser instead of paying a flat rate per acre actually buys the coal by the ton at prices graded according to the quality and the character of the coal.

In the four years following the adoption of the policy of classifying and valuing the coal lands, the sales have increased 12½% in acreage and 36% in value, as compared with the four years preceding, and this in spite of the fact that the four years since July 1, 1907, have included a period of industrial depression and slow recovery as contrasted with the preceding period of boom conditions. So far as its provision for pricing is concerned, the present law appears to be as satisfactory as a sale law can be.

In one serious respect, however, the present law is absurdly out of accord with good mining practice, in that it restricts legal purchases to a maximum of 160 acres for an individual and of 640 acres for an association. The fixed charges of a modern coal mine so equipped as to safeguard life and property and to secure maximum recovery are too high to be assessed against the tonnage of so small a tract.

The Leasing Alternative.

The difficulties involved in the administration of the present law suggest the wisdom of considering the other method of disposition, namely, a leasing system. As Secretary Fisher has stated, "It may well be that a liberal but wisely protected leasing law would be found to promote development more vigorously than any system of outright purchase."

The greatest advantage of the leasing system, both to the operator and to the public, is relief from the capital outlay now required in the acquisition of the large acreage absolutely necessary for a modern mine. This argument advanced against the present policy of valuing the public coal lands at even conservative prices thus becomes an argument for a leasehold law.

The objections made to a leasing system are, first, that the eastern coal lands were disposed of in fee and that the West deserves the same treatment; and further, that the natural resources of the West should not be made a source of profit to relieve the eastern taxpayer. The large tonnage of coal now mined under lease meets the objection to direct Government leasing, and as regards the argument of reserving the western resources for the West, it should be noted that under the present system of sale the proceeds from the coal lands go directly into western development through the reclamation fund, and it is proper to expect that any leasing law would make similar disposition of the proceeds.

Other objections express a fear that the cost of coal to the consumer would be increased; but the royalty paid into the United States Treasury can be no greater a tax upon the consumer than the royalty paid to the State of Colorado or to a railroad land company. The average price of bituminous coal at the mine in the United States last year was $1.12, which usually includes a royalty to private owners or an equivalent interest charge, either of which would probably be greater than any Government royalty.

Experience of New Zealand.

The other objection to the lease system is that based upon fears of expensive Federal management and of insufficient administration or even maladministration. If we look out across the Pacific, we discover that a Governmental leasing system for coal lands is not a theory but an actual working fact. The Anglo-Saxon peoples of the Australasian States have found the leasing system not only practicable, but indeed preferable to the sale of coal lands. In New Zealand, where for 30 years the laws have permitted to the operator a choice of either sale or lease of public mineral lands, a conclusive argument for the leasing system is given in the latest statistics of mineral production, which show that approximately 90% of the total mineral product of that country was mined under leasehold. If our trans-Pacific neighbors can administer a lease law so satisfactorily and if the mine operators in New Zealand prefer operation under leasehold, will a similar system be fraught with either danger or failure in the United States?

*From an address delivered before the American Mining Congress, at Chicago, Oct. 27, 1911.
†Director of the United States Geological Survey.

Combination in the Soft Coal Mining Industry.*

This country has, in a few years, developed a militant policy of conservation. Conservation means not only the preservation of the forests and the minerals, but it means the protection and upbuilding of the industries. The coal-mining industry, as it exists to-day, is a powerful protest against the fragmentary methods of doing business which are sought to be impressed on the country.

The moment a newspaper begins to talk about a "Coal Baron," there immediately arises in the minds of many people a griffin-clawed monster of untold power crushing the life out of toiling labor in the bowels of the earth, and dragging down to poverty and ruin the consumers of coal. Coal barons are like ghosts—no one ever saw one, but for that reason alone ignorant people believe in them. The coal operators are about the last class to whom such a term should apply, for, if there is anyone that is between the upper and nether millstone it is the coal operator.

The Mining Bureau and the Geological Survey have investigated the coal-mining industry, they know the real and true conditions, they know what causes the tragedy of the mines, they know what causes the waste and dissipation of resources, life and energy in mining operations, they know what will prompt exorbitant prices for fuel in the near future and they know what is reducing the available coal resources with frightful rapidity. To what purpose is all this put? They are given the high honor of submitting these reports with their recommendations to the industry and to the public, after which they are duly filed in Washington, not even in a fireproof building, and are soon lost to sight beneath their enveloped dust.

The operators would willingly follow these recommendations, but they must conduct their industry in a way which must conform to certain laws, and these laws, such as the Sherman Act, negative in effect the ability to carry out the recommendations of the governmental bureaus.

The recent report of the Bureau of Mines of Pennsylvania shows that there can be no progress in conservation of coal resources and of human life in coal mining until there is a readjustment in that industry in some form of concentration—until laws are made which permit such action.

Over 80% of the cost of mining coal is in the

*From an address by D. W. Kuhn before the American Mining Congress, Oct. 24.

labor, the cost of that labor plus the cost of only the most essential matters in connection with the production of coal, is now greater than the price received for it. A concern that manufactures a toy—the company that makes kodaks—shows by its reports that it made over $8,000,000 last year. The entire coal-mining industry from the Mississippi to the Pocahontas hills in Virginia did not make eight thousand cents during that time. It did worse than that, it lost and wasted human life and coal resources, to say nothing of the spent energies of the industry. In this country it has became almost a crime to say that any industry must raise the price of its product, but a higher average price must be obtained for coal.

The necessities of the country and the industry demand the lessening of the great number of coal-mining operations scattered throughout the country. In the present condition everything operates to increase the price to the public now, and to largely increase it in the future. It has been demonstrated that a multiplicity of mines is not wholesome from any standpoint; it causes bad mining, great loss of resources and increases the cost of mining. If coal were inexhaustible it might be a matter of indifference to the country how the industry was conducted, but that is not the case.

Everything in connection with this industry demands some form of reorganization on lines of concentration. The operators should not only advocate it, but do it, and the government should cooperate in such a movement if that were possible. There must be now some relation between the cost of mining coal and the price for which that coal is sold. It is not necessary to have the government fix prices, nor is it necessary to throw the entire coal industry of the country into one great company.

It would seem now that a reasonable restriction of trade and production is lawful. And in meeting that status of the law a concentration of operation in every district should be undertaken by the operators.

And now I want to sound a solemn warning to the government and to the public. When a miner has to tighten his belt in lieu of something to eat when he is hungry, and a coal operator has to pledge his mules to raise his payroll, this talk about the enforcement of anti-trust laws and of jail sentences is just about as effective with them as "tweedledeeing on melodious catgut."

Excepting some special coals, the coal-mining industry has produced its coal at a loss for the last several years in a wild competitive struggle or competitive debauch; it has for the last few years fulfilled every injunction of the proponents of unlimited competition, and the results speak for themselves. The present wage scale is high if a miner should work eight hours a day 300 days in the year—double the reward for similar work outside. But the miner cannot work more than half time, and his year's reward is meager. To the fierce competition this is due. The operator keeps 50% more miners than are necessary. The operator has to produce a maximum tonnage to prevent heavy losses; and to meet this condition he keeps open large areas of underground workings, filled to the limit with miners; and only that coal is hauled out which can be cheaply recovered. The losses from operations cannot be continued longer and a crisis is at hand. In my opinion it will reach a culmination next spring. And unless something between now and then is done to reorganize the industry, there is only one thing that the operator can do to reduce the cost line below the present selling price, and that is to cut wages. This is the last possible resort of the industry, but the operator to maintain his solvency must and will do it.

In my opinion, next spring, at the period of wage settlement with the miners all over the country, there will begin one of the worst industrial warfares this country has ever witnessed. Compared with it the prostration of railroad traffic in England a few months ago will be a holiday affair. The coal-mining industry will come to a full stop. We will have a feast of competition. The consumers of fuel will compete with each other for coal when there is no coal to be had. The miner will compete with the operator, pitting his stomach against the endurance of the operator—an endurance of despair. Into the welter of this turmoil the entire country will be brought. All this can be prevented, not by talk, by discussions, by resolutions, but by prompt, vigorous and constructive action. And if it does come, the blame, the vengeful blame of the people, will be placed where it belongs—on the government and on the weakling coal operator—for the blind and indifferent course of the one and the irresolution and weakness of the other.

Why Conservation Requires Coal Mining To Be Conducted On a Large Scale.*

By DR. HENRY S. DRINKER,† M. Am. Inst. Min. E.

The conservation—the careful mining—of our coal, and the economic development of our latent water powers, for instance, can only be managed properly by the investment of large capital, and this can to-day be supplied only by the association of many individuals having capital to invest, in large corporations controlling such aggregate capital, or by the Utopian plan of State or Federal ownership and the use of the public funds in an industrial enterprise. As to corporations, the stronger they are, the more surely are they in a position to handle the mining problem conservatively and economically. The economic mining of coal—the proper development of a water-power site, involve purely expert questions, but it takes capital to command the best expert talent.

Proper conservation of our natural resources does not mean throwing open their exploitation to the wasteful methods and inexperienced handling of individual operators with the unnecessary duplication of plants and the waste of capital involved in uneconomic individual operation. Conservation of our natural resources does not mean the conservation of the individual operator. As a rule it points to reasonable cooperative effort lawfully exercised in the interest of that economy in methods resulting from operating on the larger scale that conserves our resources for the benefit of the consumer and prevents their waste by the producer.

Much of the twaddle that is talked and written arises from a sentimental sympathy for the individual operator who is often the worst enemy of true conservation. As a rule there is no more wasteful system of mining than that pursued by the small individual operator. The man who owns, or leases, a small mine, or who leases a large mine for a limited period, on limited capital, is almost certain to mine extravagantly. He absolutely must get all he can out of it in the cheapest way possible. He is not concerned with laying out deadwork ahead—with planning far in advance so as to take out the largest possible amount of coal or mineral in the most economical way. He has the power, within certain bounds, as a rule, under his lease, to so operate as to get the largest amount out of the mine in the cheapest and quickest way possible, practically regardless of the waste in mining.

Moreover, the small individual operator is, as a rule, absolutely indifferent to the interests of the public, whereas a large corporation, doing business not for a limited term, but for time, must so conduct its business as to be content with a moderate and reasonable profit on a product mined economically, and with a far-seeing eye to the conservation and avail of all its resources, and to the just treatment of its customers.

The Penetration of Inorganic Preservative into treated wood can be determined by a visual method described by Mr. E. Bateman, Chemist in Forest Products, U. S. Forest Service, in Circular 190 of the Service. A representative disk of the treated wood is cut and, in the case of zinc chloride preservative, the freshly cut surface is dipped for not more than ten seconds in a 1% solution of potassium ferrocyanide. The excess is removed by blotting paper and the block dipped into a 1% solution of uranium acetate and allowed to dry. The un-impregnated portions of the disk will have a dark red color while the treated portions will be slightly whiter than the natural wood. Careful chemical tests of the preservative content of different portions of sample disks has shown that as small amounts of zinc chloride or 0.2 lb. per cu. ft. can be thus detected. This test is not successful with red oak on account of the natural color of the wood. In testing for penetration of a copper-salt preservative, it is necessary to dip only once—into a solution of potassium ferrocyanide; the penetrated zone is shown by a dark red stain. The same test for penetration of an iron salt would show a deep blue stain. Mercuric chloride can be tested for with a solution of hydrogen sulphide, which replaces the mercuric chloride with a black sulphide, showing as stain. The solution is conveniently prepared by acidifying a solution of sodium sulphide.

*Extract from an address before the Michigan School of Mines.

†President of Lehigh University, South Bethlehem, Pa.

Notes on Railway Ties.

Some new ideas regarding railway ties were presented in three of the committee reports submitted at the annual convention of the Roadmasters and Maintenance of Way Association, which was held at St. Louis in September.

DIMENSIONS OF STEEL OR CONCRETE TIES.—In a report on steel and concrete ties it was suggested that such ties might be made somewhat wider and thinner than the ordinary wood tie, and would answer their purpose effectively. There might then be a smaller number of ties to give the required bearing area, and there would be less labor in placing the tie and in tamping it in place. We may note that in this country the tendency of late years has been to increase the common 6-in. depth of wood ties to 7 ins. on account of the greater stiffness required to carry modern heavy loads, but that in England the almost universal practice is to use main line ties 10 ins. wide and 5 ins. deep (upon which are cast-iron chairs carrying the rails).

PILING TREATED TIES.—In piling ties along railway track for future use it is customary to lay the alternate rows or courses at right angles to each other. In a report on the treatment of ties it was suggested that a good way for piling creosoted ties is to lay them all in the same direction and to have in each course one tie less than in the course below. Thus a pile with 12 courses and 12 ties in the bottom course would contain 78 piles. It was claimed that with this arrangement the removal or theft of any ties would be readily noticed, and that the pile can be protected by passing a single strand of wire over it, fastening the wire to each outside tie.

CHEAP TIES ON BRANCH LINES.—The report on soft ties indicated preference for hard wood ties in general practice, both on main and branch lines, and at freight yards, etc. Ties of soft wood, however, were considered suitable for tracks in car repair yards and for storage tracks at yards, mines, etc., where the loads, speed and traffic are light enough to warrant the use of light rails and inferior ballast. As to branch lines, the report states as follows:

We hear much of cheap ties on new branch lines where the argument is presented that the traffic is light and the cedar tie on account of its long life will give all the service that is necessary for years to come. Then, if the line proves profitable and new business is developed, a more permanent construction can be furnished. This argument is good if it were given to the management to foresee what each branch line will do in the coming ten or twenty years. But railway business is at best a variable quantity and the line that sees but one local train each way a day when built may in a year be the only outlet to coal or oil fields undreamed of when built.

Your committee investigated among other cases one track 34 miles long that was built of gravel ballast, cedar ties and 65-lb. rail that answered every purpose for 13 years when almost in a night a stone field was developed, coal was diverted from another line and merchandise runs were sent over this line on account of better grade than the old line. The heaviest engines and cars of 100,000 lbs. capacity replaced the little coal train and the cedar ties were found entirely inadequate to the demand put upon them.

The first means of improving conditions was to replace 1,500 cedar ties with oak ties the first year and to change out the balance as fast as they could be reached each year. The gravel ballast stood the strain as well as the light rail and after five years of heavy traffic the same rail is still in service and in good condition. At the time the cedar ties were taken out they were as sound on top as when put in although slightly decayed from the bottom. Under the rail they were crushed from 1-in. to half way through and cut to pieces with spikes where they had been driven to restore the spreading gage.

At the time this line was built the soft ties cost 50 cts. each and oak ties were worth only 35 cts. each, the cedar ties being selected because they were known to be of long life and there was no apparent reason why they should not give all the services that would be demanded of them for 25 years. When built, all the ties in the track were protected by light tie-plates, which were the heaviest plates on the market at the time. These tie-plates proved of very little benefit when the heavy traffic was put on the line.

Recent Flood Conditions on the Cedar River, Near Seattle, Wash.

By GEORGE HOLMES MOORE.*

Within a period of less than twenty-four hours, the unprecedented volume of flood-waters which poured down the Cedar River valley on Sunday, Nov. 19, 1911, wrought an immense amount of damage to wagon and railroad bridges, cut off the water-supply of the city of Seattle, and caused a total suspension of traffic on the Chicago, Milwaukee & Puget Sound R. R.

Outline of the District Involved.

DRAINAGE AREA.—The Cedar River drainage area (Fig. 1) is of the highest importance to the city of Seattle, since it provides the entire water-supply of the city, and also furnishes energy for the municipal hydroelectric plant at Moncton. All of the drainage area tributary to the water-works intake at Landsburg is under the control and patrol of the health department of the city. Most of this area has already been acquired by the city through condemnation proceedings or otherwise, and the acquirement of the rest is now under condemnation.

The area tributary to the timber dam at Cedar Lake is about 79 sq. mi.; that tributary to the masonry dam, now being built 1¼ miles below, is about 83 sq. mi., and the total tributary to the water-works intake at Landsburg, 15 miles below the lake, is about 136 sq. mi.

THE RUN-OFF.—The run-off from this drainage area, and especially from the upper area, is so large as to strain the credibility of those unacquainted with hydrographic conditions in western Washington, and especially in the Puget Sound basin. A publication of the U. S. Weather Bureau sets forth the situation as follows:

> The heavy precipitation of some portions of the section is due, of course, to the mountains, but were its whole surface uniform and of low level, western Washington would still be well watered in the winter, or "wet season," for it extends across the highway of the atmospheric vortices, or low-pressure storms, that move from the North Pacific Ocean into the interior of the continent. But, as the case is, the Olympic coast range of mountains forces the vapor-laden atmosphere coming from the ocean into higher elevations, producing an excessive precipitation in the coast counties; and again, the Cascades, lying athwart the prevailing course of the currents, reproduces the same effect over their western slopes and foothills. There is, therefore, a heavy rainfall in the coast counties ranging from 60 to 128 ins. annually; 22 to 60 ins. annually in the Puget Sound Basin; while *from 60 ins. upward to an unascertained limit* is precipitated annually on the western slope of the Cascades. As a consequence of the heavy precipitation and resultant snow fields in the mountains, as well as the heavy forestation that prevents a too-rapid run-off in the spring, there are many rivers, not of great length but swift flowing and deep, *discharging enormous volumes* of water into the Puget Sound Basin, the Pacific Ocean directly, and the lower Columbia River.

The same bulletin gives a mean annual discharge in second feet per square mile of drainage area—a unit of the highest importance, but one much neglected outside of the U. S. Geological Survey—of 5.89 sec. ft. for the Snoqualmie drainage area of 440 sq. mi.; of 6.71 sec. ft. for the Skykomish area, of 340 sq. mi., and of 3.74 sec. ft. for the Yakima River (near Cle Elum) of 500 sq. mi. In connection with the last item it is to be noted that the Yakima flows from the eastern slope, but that even its headwaters have, for an area of 56 sq. mi., a mean annual discharge of no less than 7 sec. ft. per sq. mi. (See "Yakima River near Martin, Wash., for 1909," Water Supply Paper 272, p. 157.)

As the latter drainage area is just over the divide from that of Cedar Lake, and as the lake has the usually wetter, western exposure, much light is thrown on the flood herein described.

The above facts concerning drainage area and run-off are cited at length, since in no other way can this account be freed from a suspicion of exaggeration.

CAUSE OF THE FLOOD.—The main flood volume seems to have been generated in the Cedar Lake basin tributary to the timber dam, an area, as previously noted, of some 79 sq. mi. The recorded rainfall at this point was 6.9 ins. for the 46-hr. period from 10 p. m. Friday to 8 p. m. Sunday. This, while remarkably large, is by no means the maximum for this gaging station. The three days of the highest precipitation noted were in the year 1906:

	Ins.
Nov. 13	4.64
Nov. 14	6.16
Nov. 15	5.10
Three-day total (Cedar Lake)	15.90
Mean annual (Cedar Lake)	112.0
Mean annual, Seattle	36.0

Now the three-day precipitation above noted, while it did indeed produce the largest flood recorded previous to the one herein discussed, was not nearly as large as the latter, and the cause therefor, or rather the contributing causes, which, in connection with the high precipitation given, produced this freshet, are almost undoubtedly the large volume of snow in the mountains and the deadly "Chinook" wind which prevailed at this time. Snow as high as "5 ft. on the level," and of unknown depth in drifts, was reported from the Cascade summits just prior to the flood.

The Flood.

On Saturday, Nov. 18, 1911, it became evident, by reason of the rapid rise in lake level, that

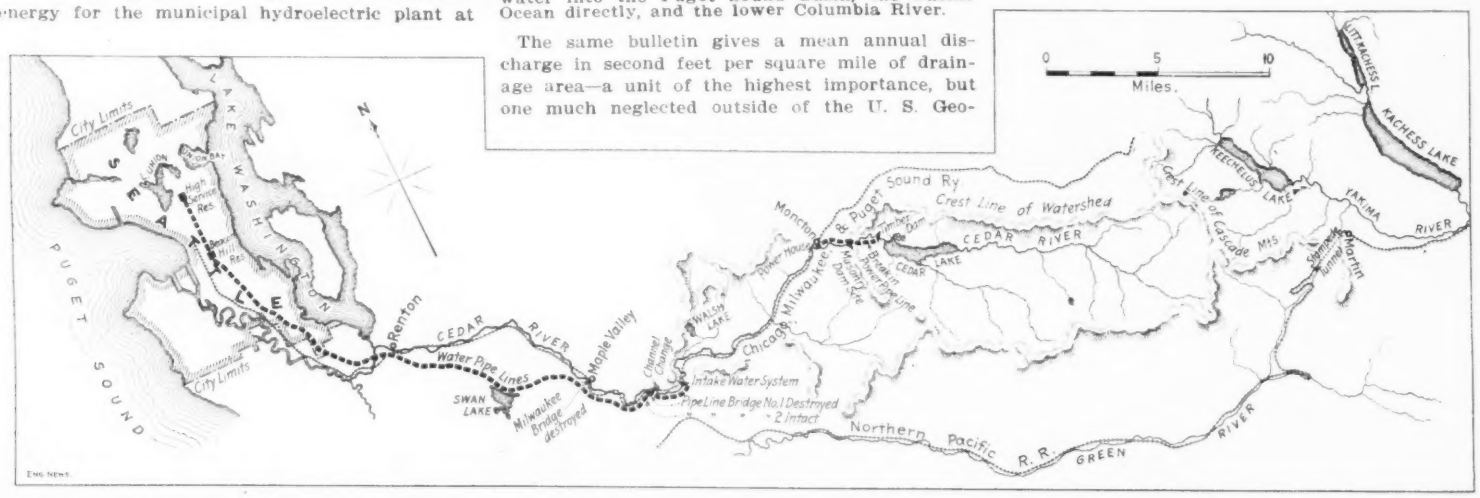

FIG. 1. SKETCH MAP OF THE DRAINAGE AREA OF THE CEDAR RIVER, NEAR SEATTLE, WASH., WITH LOCATION OF STRUCTURES DAMAGED BY THE FLOOD OF NOV. 19, 1911.

Fig. 2. Water Passing Over Cofferdam, Saturday.

Fig. 3. Wrecked Cofferdam, Sunday.

FIGS. 2 AND 3. COFFERDAM ON CEDAR RIVER AT SITE OF PROPOSED NEW WATER INTAKE, BEFORE AND AFTER FAILURE WHICH TOOK PLACE AT 9 P. M., SATURDAY, NOV. 18, 1911.

trouble was to be apprehended, and the gatekeeper at the Cedar Lake timber dam got into communication over the municipal telephone line with the lighting superintendent, Mr. J. D. Ross, at Seattle, some 43 miles distant. Constant communication was maintained over this line, and all possible defensive measures were taken. The height of the flood on the crest of the dam was 4.8 ft. on Saturday morning, this being the gage reading at 6:30 a. m. The water rose steadily over the 2 sq. mi. area of the lake, and at 9 p. m. the reading was 7.4 ft. above the dam

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crest. The probable discharge at this time was about 8,000 sec. ft. from the contributing area of 79 sq. mi., the largest ever noted previously having been 7,500 in November, 1906.

FAILURE OF WAGON BRIDGE AND COFFERDAM.—At 9 p. m. Saturday, under the conditions just given, the failure of the wagon bridge and cofferdam occurred. The bridge was of wooden-truss construction, on timber-crib piers, which stood perhaps a hundred yards down the stream from the dam. The cofferdam was also of timber-crib construction and had just been completed to control the stream during the erection of the masonry dam and was located 1¼ mi. downstream from the timber dam. (See views before and after failure, Figs. 2 and 3.)

CREST OF FLOOD.—Following the destruction of these structures, the lake level continued to rise until at 7:30 a. m., Sunday, Nov. 19, the head on the crest of the dam was 8.2 ft., by far the highest elevation in the history of Cedar Lake. (This lake lies at an elevation above city datum of 1,555.9, the original lake-level having been 1,530.) At this time the discharge is estimated to have been 9,500 sec. ft., or 120 sec. ft. per sq. mi. of drainage area, a truly formidable figure.

Three-quarters of an hour later, at 8:15 a. m., Sunday, the 5-ft. addition to the dam, which was finished Dec. 28, 1909, was unable longer to stand the strain. It gave way and was swept clear of the spillway. (See Fig. 4.) This increased the effective depth of discharge to approximately 13 ft. and the volume of discharge to probably about 19,000 sec.-ft.

FIG. 4. CEDAR LAKE DAM, AFTER 5 FT. OF THE TOP OF THE STRUCTURE HAD BEEN CARRIED AWAY.
This view was taken about 8:45 a. m., Sunday, Nov. 19, 1911, probably within a half hour after accident.

THE DAMAGE DONE.—The power pipe-lines of the municipal electric plant, sunk beneath the river bed a half mile below the timber dam, were scoured of their stream-bed covering, and the larger one (a 68-in. wood-stave pipe) was carried completely away. Continuing on down the stream, the flood waters tore out everything within their reach.

The most important damage was the destruction of the pipe-line bridge No. 1 at a point about ¾-mi. below the water-works intake dam at Landsburg. Fig. 5 is an excellent view of the bridge, the piers in the middle of the picture being those which gave way under the attack of the flood. (See also Figs. 6, 7 and 8.)

The failure of this bridge is claimed by the newspapers to have been caused by the shortening of a bend in Cedar River made by the Milwaukee Railroad to avoid the construction of two bridges at this point. This change not only increased the slope, and hence the velocity, of the stream, but also tended to concentrate the flow against the abutment piers, whose failure caused the destruction of the bridge and the cutting off of the city's water-supply. This claim is strengthened by the fact that pipe-line bridge No. 2, of similar construction, and built at the same time, which is but little more than a quarter of a mile below bridge No. 1 (Fig. 9), was unharmed by the flood.

The piling of the water against the piers, and the spur-track built by the Milwaukee to aid in their protection, are well shown in Fig. 6. Continuing on down the valley, the flood and its accumulated wreckage tore the steel bridge of the Milwaukee Railroad at Maple Valley from its anchorage, dropped one end of it into the river, covered it with wreckage, and tied up traffic on that road for a period of two weeks.

Careering onward, the flood massed the wreckage against the railroad bridges in the vicinity of Renton, drove the occupants to the hills, and finally, spreading southward along the White River valley and northward along the Duwamish valley, united with the swollen waters of Green River to submerge all the valley towns within a distance of twenty miles.

Relief Measures.

As a result, then, of this flood and of its attendant disasters, the city of Seattle found it-

Fig. 5. Full View of Bridge Before Failure.

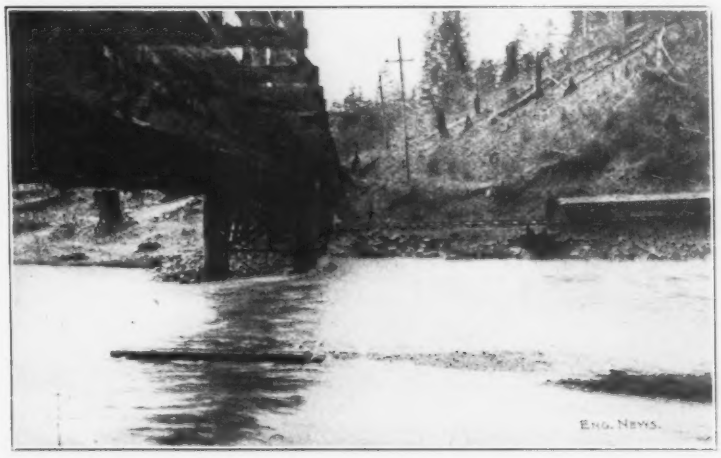

Fig. 6. View of Part of Bridge on April 2, 1910.
(Note end pier in center of view, Fig. 5; also same pier, in Fig. 6, with water backed up by and against it. The spur track shown in Fig. 6 was used by the Milwaukee Railroad to place material to protect the bridge.)

Fig. 7. Clear Gap in Pipe-Line and Bridge.

Fig. 8. Wreck of Pipe-Line Bridge.

FIGS. 5 TO 8. PIPE-LINE BRIDGE NO. 1, SEATTLE WATER-SUPPLY CONDUIT, BEFORE AND AFTER BEING WRECKED BY FLOOD OF NOV. 19, 1911.

self, on Monday morning, Nov. 20, 1911, confronted by a critical condition. The water-supply was completely cut off, the light plant was completely out of service, and, worst of all, traffic communication with the scene of disaster was closed by reason of the failure of the Milwaukee Railroad bridge at Maple Valley. Even to get to the scene required the most heroic of measures, for the Snoqualmie and Green Rivers were also in flood, and all the railroad schedules were in the condition condensed in the laconic remark, "Come around this afternoon. May have a train out then."

But by divers and roundabout methods and routes, the city officials rushed to the breaks in the various pipe lines. Mr. R. H. Thomson, formerly city engineer of Seattle, and Mr. R. H. Ober, building superintendent, arrived at Landsburg on Monday afternoon, to find Mr. L. B. Youngs, water superintendent, already on the

Fig. 9. Pipe-Line Bridge No. 2, Seattle Water-Supply Conduit, Unharmed by Flood of Nov. 19, 1911.

ground. Work was at once initiated looking to the replacement of pipe-line bridge No. 1. The problem to be met was the repairing of a gap, some 250 ft. in extent, both the 48-in. and the 60-in. wood-stave pipes having been swept away at this point, together with the 150-ft. wooden truss bridge which had supported them.

As the supply of water was inadequate for more than six days, there was no time for the construction of a truss bridge, and all energy was concentrated upon the construction of a pile bridge across the swift current—anything to restore the water-supply within the briefest possible time. Here new difficulties were met. There was no pile-driver anywhere near the break, and the Milwaukee was cut off. A pile driver was finally secured at Seattle, and, after traveling over a circuitous route of the Northern Pacific via Puyallup to Enumclaw and of the Milwaukee Railroad from Enumclaw via Moncton to Landsburg, this driver arrived at the latter place at 2 a. m., Tuesday, Nov. 21. Here again was fresh trouble, for the Milwaukee line to the break was washed out, and the driver had to be hauled over the wagon bridge at Landsburg and thence down the pipe-line grade about three-quarters of a mile to the break, where it arrived at 10 p. m., Tuesday.

Now at the time the driver was ordered from Seattle, the piles for the bridge were still standing in the form of fir trees in the surrounding forest. By the kindly and timely assistance of the logging firm of MacDougall & Biladeau of Landsburg, these firs were felled, logged and sent down the repaired Milwaukee track to the break. Here they were transferred by cable across the river to the pile driver. The first pile was driven at 2:30 p. m., Wednesday, and by 2 a. m., Friday, the last of the 72 piles had been driven into the hard cemented gravel and boulder bottom of the stream, the actual driving time being about 25 hours. This work was done under the supervision of Mr. Ober, Mr. Thomson having returned to his new duties as engineer for the port of Seattle. During the construction of this bridge, all concerned worked regardless of time. The men worked 18 hours continuously on Wednesday and 20 hours continuously on Thursday.

Meanwhile the work of assembling and banding the new 60-in. wood-stave line was being carried forward under the direction of Water Superintendent Youngs. Work was begun on this pipe about noon, Thursday, and was finished at about noon, Saturday, during which time 300 ft. of pipe had been constructed.

Immediately upon the completion of the pipe and the testing of the banding, water was turned into the pipe and started on its way to Seattle, a little less than 28 miles away.

This ended a break in the water-supply system of almost exactly six days duration. While the newspapers made much of the spectacular features of this "Water Famine," very little actual hardship resulted to the citizens of Seattle. Emergency plants began pumping from Union Bay in Lake Washington, using the pumps which formerly supplied the Alaska-Yukon-Pacific Exposition. These pumps started at 10:30 p. m., Wednesday. The two sets of high-power centrifugals used on the Denny Hill regrade, having a joint capacity of 12,000,000 gals., were rushed to Leschi and Madrona Parks on Lake Washington, and began service about 7:30 p. m., Friday. Electrically-driven, belt-connected centrifugals of low lift, also of 12,000,000 gals. daily capacity, were rushed to Swan Lake, and began pumping into the pipe line at 3 a. m., Friday. Assistant Engineer D. W. McMorris and District Engineer T. H. Carver were in charge of this branch of the relief work.

City Engineer A. H. Dimock and Lighting Superintendent J. D. Ross were actively engaged in the repair of the crippled hydroelectric plant at Moncton.

As first aid to the injured, a "cross-over" was built between the 49-in. and the 68-in. wood-stave pipes, at the point of break in Cedar River, about a half mile below the timber dam, the 68-in. pipe having been carried completely away at this point. By this means connection to the dam was had through the 49-in. pipe, which, though badly battered in many places, and spurting a geyser through a large break in the river channel itself, was still able to deliver through the 30-in. cross-over to the 68-in. pipe sufficient to produce 2,300 KW. output from the plant at Moncton. This cross-over, whose size was dictated by the elbow fittings obtainable, was finished at about 3 p. m., Thursday afternoon, and the first power was generated that night. The City Plant's load had meanwhile been carried by the Seattle-Tacoma Power Co., a private corporation, generating power at Snoqualmie Falls.

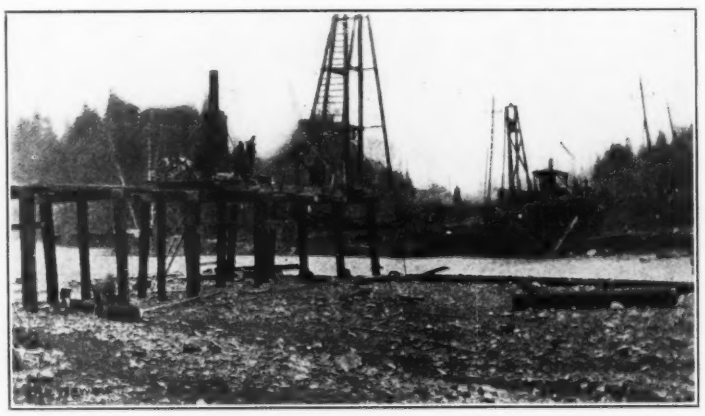

FIG. 10. REPAIRING PIPE-LINE NO. 1, SEATTLE WATER-SUPPLY CONDUIT; PILE DRIVERS WORKING FROM EACH END OF BREAK.

Conclusion.

Taking all in all, it is believed that a serious condition has been weathered through by the city of Seattle with but little actual damage done. No fires have broken out and no disease outbreak has been reported or is now anticipated. Remedial measures are being prosecuted looking to the elmination of the bridges on the water pipe line, and the construction of the masonry dam at Camp Two, a mile and a half below the timber dam, will effectively obviate any future danger to the power pipe lines of the city light plant.

Irrigation in Wyoming increased from 605,878 acres watered in 1899 to 1,133,302 acres in 1909, or 87%. This increase was small compared with that in the cost of irrigation works, which rose from $3,956,692 in 1899 to $17,700,355 in 1910, or 347%. Only 1,615 acres were supplied by pumping in 1910.

Medieval German Street Cleaning Regulations—In a small German pamphlet ("Der Strassenkericht," by Dr. Clemens Dörr. Published by Goscking, 29 Uhland-strasse, Berlin, W. 15) upon street refuse and street cleaning we have come across some interesting details of the earliest regulations issued by municipalities for the purpose of maintaining their streets in good order. In 1367 the town authorities of Muehlberg made a regulation to the effect that manure must not be allowed to remain in the market place longer than fourteen days, against a penalty of "72." What coin this figure referred to is not stated, but it was certainly one of the first steps along the line of progress to inflict a fine at all. Later in the year 1735 a much more elaborate set of regulations was issued by the Government and published by the authorities of the town of Celle. The first clause states that the street scrapings (mud) must be swept together on those evenings and in those streets where a bell is rung. The bell is rung again the next morning in the same streets, and upon this signal the street refuse, together with the ashes from the houses, must be thrown into the carts immediately—apparently the bell was rung in the morning as the cart went round. Further, somebody had to see that a sweeper was provided to sweep up after the cart, and a penalty of two thalers was prescribed for non-compliance with this clause. Clause 2 forbids the mixing with the street scrapings of rubbish, which must be got rid of by everyone at their own expense, and refuse must not be thrown out on to the streets, or swept into the streets, but must be brought direct out of the houses when the cart is passing and tipped into the cart at once, the penalty for non-compliance being two thalers. Clause 3 forbids the throwing of glowing peat ashes or coal on to the street or into the manure pit. These materials had to be placed in a safe spot, well extinguished with water, and kept until the cart came round. In this case the failure to carry out the instructions resulted in a fine of eight thalers for the house-owner and imprisonment for the servants. Clause 4 deals with broken bottles and crockery, which it was forbidden to throw on the streets, and again the penalties were a fine for the occupier and imprisonment for his servants. Clause 5 stated that building rubbish had to be carted away, but if an entire house were pulled down the rubbish could remain in the street for eight days without a fine being incurred. Clause 6 provided for a penalty in the case of carpenters, wheelwrights, turners, coopers, bricklayers and masons if they allowed timber, stones or tools to encumber the footways and doorways. Other clauses prescribed that manure should not be brought out except upon the day on which it would be carted away, and then only as much as could be taken away the same day. From a further clause it would appear that much litter was caused by feeding horses in narrow streets, and this was forbidden, and was only allowed in wide streets with the consent of the occupiers of the houses, and on the condition that the occupiers cleared the street every evening and kept the doorways and passages clear. The final clause of this interesting set of regulations is drastic, and may possibly appeal to some of the officials of to-day. On Saturdays all the streets in which the dustcarts had been during the week were inspected, and any rubbish, dirt or refuse found on the pavement was gathered up and thrown into the house without regard to the person, fines being inflicted as well.—"The Surveyor," London, Sept. 1, 1911.

The American Institute of Electrical Engineers on Water-Power Development; Hearings Before the National Waterways Commission.

On account of the unsatisfactory situation existing in the development of water-powers of the country, the National Waterways Commission some time since set the date of a public hearing for the discussion of these questions, in Washington, on Nov. 21. A number of societies and individuals interested were invited to attend and contribute to the discussion. The directors of the American Institute of Electrical Engineers accepted the invitation and authorized the cooperation of its Public Policy Committee and such other members of the Institute as the Committee desired. The views of the Public Policy Committee were put in the form of a brief, which was submitted to the Commission after the hearing. Some of the important paragraphs are appended herewith.

At the hearing, the President of the American Institute, Mr. Gano Dunn, of New York City, defined the attitude of the American Institute and discussed some of the factors determining the rates for water-power, the statistics of developed and undeveloped powers and the engineering advantages of interconnection of contiguous systems. Past President L. B. Stillwell, of New York, discussed the distances over which transmission was possible and the causes of interruption in hydroelectric systems compared with steam-electric systems. He also pointed out that the value of a stream as a source of power was usually much greater than its value as a waterway.

Mr. Calvert Townley, of New York City, took up the difficulties under which hydroelectric systems labored at first from failure of expected market development and also the functions of steam auxiliaries in connection with hydroelectric systems.

Mr. H. G. Stott, of New York City, presented information on the rate at which the cost of coal had been rising in the last decade and how the amount of coal consumed per horse-power in steam plants had been falling. The influence of similar competition on the rates of hydroelectric companies and the first cost of steam-electric stations was discussed.

Mr. J. H. Finney, of Charlotte, N. C., described the interconnections of the several plants of the Southern Power Co. and the engineering and commercial advantages that resulted.

Brief of the American Institute of Electrical Engineers.

The function of the American Institute of Electrical Engineers is scientific and professional, and is not commercial; consequently, its committee refrains from expressing itself on the commercial, industrial, legal or political aspects of the water-power situation, except when these are incidental to the effect of that situation upon the practice of electrical engineering which it is the Society's object to promote.

RELATION OF WATER POWER TO NAVIGATION.—That the utilization of rivers and smaller streams for navigation and for the development of power are naturally interrelated is obvious. As regards by far the greater part of our undeveloped water powers on the public domain, the ultimate value as sources of power of those streams is vastly greater than any possible value which could be realized by attempts to utilize them as channels for navigation.

WATER POWER A PUBLIC UTILITY.—Modern water-power developments usually are not local private enterprises, as is generally supposed. The developments in recent years in the electrical transmission of power have made possible the distribution of electric power from a single water-power plant over territories embracing in some cases over 40,000 sq. miles in area, supplying electric power for diversified purposes to hundreds of thousands of people. Such distribution of water power is an advantage to the consumers, and any policy tending to retard or handicap the development of water powers is a disadvantage to the people in the surrounding territory and retards its industrial development.

The regulation of public utilities by public service commissions has become practically an accepted principle in the United States, and there is no reason why safeguard from unfair charges for water power should not be found by this means.

COMPETITION BETWEEN WATER AND STEAM POWER.—The belief among certain classes of the public that water powers yield excessive or disproportionate profits springs primarily from two causes—the conception that the water itself is the power and that the expenses of operation of a water power are small while the company's income is large.

It is difficult for the public to regard the dam, the power house, and its appurtenances once built as involving continuing expense, but they do. This expense is comparable in amount with the cost of coal in a steam station, and is the return due to the capital invested. It takes the form of interest, sinking fund expenditures, depreciation and taxes. The invested capital in a water power is so much greater than the public realizes, that with interest charges at not more than 5 or 6%, in a majority of cases, from 70 to 80% of a water power company's income is absorbed. This return to capital is not profit. Without the prospect of it, capital cannot be secured.

Practically all water powers come to birth or not on the answer to the question "What is steam power in the territory costing?", and they can live only when they deliver power at a substantially lower cost. At the same cost, they remain unborn.

Besides the cost of power, the relative amount of investment is a determining factor. While at present a steam electric plant can be built for $75.00 per horse power the cost of a hydroelectric plant varies from two to four times that amount. Part of this difference is because the steam plant can be built near the center of its market, while the water power is almost invariably at a distance. With the capital required for a water power so much greater, the tendency is to build a steam plant, even if the power it delivers is not as cheap as that of a water power. If it can be shown that water power can be delivered for, say, $25.00 per horse-power per year, but that steam power can be produced for, say, $27, the water-power plant will not be built, and the steam-power will. If, however, the water power could be delivered for $24.00, the difference might turn the tide in favor of the hydroelectric investment.

Attention is often called to the increasing cost of coal with an implication that the cost of steam power will rise, permitting hydroelectric companies to raise their rates and exact undue profits. The implication is not correct. It is true that the cost of coal is rising, but it is also true that steam engines and boilers are constantly being improved in efficiency, and that the art of producing power from steam is progressing at a rate so much more rapid than that at which the price of coal is rising that the cost of steam power is continually falling. Should a limit to this fall be reached, which is not yet in sight, gas and oil engines are making such constant reductions in the cost of power that there is no probability that water powers will be free from the controlling competition of other kinds of prime movers. It is safe to say that extortionate rates in water power are highly improbable even if the principle of rate regulation by commission were not applicable to hydroelectric companies.

REVOCABLE OR LIMITED-TERM PERMIT.—The revocable permit for the construction of a hydroelectric system does not attract capital because of the obvious uncertainties involved. In case of revocation, not only would the power plant and dam be forfeited, but all of the transmission lines, sub stations, and distribution system dependent thereon for their operation jeopardized. Not only is it difficult to induce capital to invest in such a development based upon a revocable permit, but it is very difficult to close the long-term power contracts with consumers which are necessary to make a hydroelectric system financially successful. Consumers are unwilling to make their future business requiring power dependent upon a permit which might cause at any time the complete disorganization of the system supplying their power.

With a limited definite term beyond which renewal of rights are uncertain, no company would be willing to continue indefinitely the extension and improvement of a system so necessary and desirable from the standpoint of public service. The necessity of writing off not only the original cost of the plant, but the continual annual investment in additions thereto within the limited term of the permit requires an annual sinking fund that adds materially to the cost of the water power. This is a hardship, not only upon the power company, but upon the consumer.

Before the end of such limited permit development of the system would cease, maintenance expenses would be cut to a minimum, and the plant would deteriorate to a point where the service to the public would become unsatisfactory.

INTERCONNECTION OF CONTIGUOUS HYDROELECTRIC SYSTEMS.—It has been suggested that with the growth in extent of large hydroelectric distributing systems ultimate interconnections and combinations between them might establish a monopoly and permit the raising of prices for power.

Such interconnection between contiguous hydroelectric systems offers decided and important engineering advantages. It improves the constancy of electrical pressure and enables the system to draw power from two or more independent power plants.

The rainfall occurring at different times on two or more separate watersheds are thus made to benefit all of the consumers on the combined systems.

Such interconnection also permits reduction in operating expenses and assures better service by reducing to a minimum the probability of total interruptions at any time from line troubles or otherwise.

The investment and consequently the cost of power can be reduced by combination, because less capacity in generating machinery to serve as spare plant for emergencies need be installed, and operating expenses can be reduced by rendering repairs easier, owing to greater facilities for shutting down for work or for inspection.

Any tendency towards raising the price of power as an accompaniment of such combination is restrained automatically by competition with steam power, and can be regulated by government commission.

EXTENT OF WATER POWER DEVELOPMENT.—The statistics of water power collected under the direction of Congress several years ago and embodied in the Report of the National Conservation Commission of 1909, show that there is at present developed in the United States about 5,000,000 HP.

The amount of power produced by steam from coal is difficult to estimate, but is considered to be about 27,000,000 HP, and is rapidly increasing with attendant depletion of coal reserves. A large part of this it is not only possible but easy for water power to replace if it were made freely available through development. Within range of development at a cost of investment that would make the cost of such power about equal to that of steam power, there is still undeveloped in the streams of the United States about 35,000,000 HP.

Any action by Congress that would accelerate the release of this power would conserve enormous supplies of coal for such domestic and industrial purposes, as only coal can supply.

PUBLIC POLICY COMMITTEE.—Henry G. Stott, Chairman; H. W. Buck, John J. Carty, Gano Dunn (Ex-Officia), John H. Finney, Charles W. Stone, Calvert Townley, James G. White.

ADVISORY MEMBERS.—Edward D. Adams, Philip P. Barton, Louis Bell, Dugald Jackson, William S. Lee, Lewis B. Stillwell, Percy H. Thomas.

Manufacturing Establishments in Greater New York in 1909 are the subject of a bulletin recently issued by the U. S. Census Bureau which gives "tentative summaries" of general statistics. There were 25,938 establishments with a total invested capital of $1,364,353,000. A total of 554,002 wage earners and 97,453 salaried officials and clerks worked in these factories to produce an increase in value of $937,538,000 in the $1,092,155,000 worth of materials used. Thus the total value of the products was $2,029,693,000. Salaries and wages amounted to $445,772,000 and other expenses, not including rent, to $266,034,000.

It appears, then, that the work of about 650,000 employees produced a value of about $670,000,000. This is about $1,030 per employee per year. Salaries and wages amounted to about $680 per employee per year. The number of salaried officials and clerks amounted to nearly 15% of the total number of employees.

The average total value of the product per factory was nearly $80,000. Only establishments conducted under the factory system were included, however, and only those having an annual production valued at more than $500. The increase in the number of factories in the five-year period since 1904 was 24%, while the value of products increased by 33%.

A Test of Watertightness of Concrete Tunnel Lining Under High Head.

By C. RAYMOND HULSART,* Assoc. M. Am. Soc. C. E.

A recent test in the Wallkill Pressure Tunnel of the Catskill Aqueduct, on the new water-supply for New York City, showed the practicability of making concrete construction watertight against high heads. The test was made upon the concrete lining of the tunnel, which is being constructed of a nominal 1:2:4 concrete without the use of any waterproofing material.

Construction of Tunnel.

DESCRIPTION OF LINING.—The concrete lining, constructed in circular section, is designed as an arch to withstand the maximum ground-water head when the tunnel is empty and to prevent leakage into the tunnel when empty or outward when in service. The unbalanced head in the tunnel when in service, i. e., the difference between the external ground-water head and the internal hydrostatic head, is much less than the ground-water head when the tunnel is empty (Fig. 1). The required minimum thickness of lining is 10 ins. to the "A" line (Fig. 2). The required average effective thickness is 15 ins. to the "C" line. As actually constructed, the average thickness of the tunnel lining is 20 ins. on account of overbreakage in excavation.

The lining is placed with keyed joints in three different operations, as shown in Fig. 2.

First—Invert 5 ft. wide.

Second—Sidewalls up to the horizontal diameter.

Third—Arch, including the key, 30 ins. wide.

The sidewalls and arch are placed in lengths of 40 to 60 ft., with keyed expansion joints between different day's work. The horizontal joints between invert, sidewall and arch very seldom show any leakage of ground water. The transverse expansion joints, especially in the upper part of the arch, show leakage as described below.

It is impracticable so to pack the concrete in the top of the arch as to give a bond to the rock. Consequently, there is a void space over the arch of an inch or less in height, extending the full length of the lining and about 10 ft. wide. To grout this void and the transverse joints in the arch three 2-in. steel pipes are placed at each arch joint (Fig. 2). Beside these three, frequent pipes are placed at low and high spots in the roof profile for grouting. Pipes are also placed at all springs or leaking seams, with collecting pans and drains to carry the leaking ground-water through the concrete and forms during construction. These will also be grouted later under high pressure (250 to 300 lbs.) to seal up the leaking seams.

DESCRIPTION OF TEST SECTION.—The section of tunnel lining chosen for the test is 180 ft. in length near Shaft 5 (Fig. 1). It was chosen on account of being probably one of the least watertight sections, as it includes a short stretch of lining through which there is evidence of seepage of ground-water, due to partial failure of drains and weepers. This seepage is through the sidewalls, and is principally noticeable on account of slight dampness and sulphur stains from the ground-water, the total amount of seepage through the concrete previous to the test being estimated at less than ½ gal. per min. in a length of 200 ft. The leakage from this section through grout pipes previous to the test was 20 gals. per min. The distorted and crushed condition of the rock, with the consequent leakage into the tunnel is shown on the longitudinal section (Fig. 3). The seepage through the concrete and dampness, due to condensation, is shown on the developed plan (Fig. 3), with the increase in these dump areas during the test. The attached photograph (Fig. 4) shows the test section before checking the flow from grout pipes. Pipe 52 is seen flowing 5 gals. per min. at a cross expansion-joint marked by dampness and sulphur stains of seepage. In the left foreground are marks of seepage through sidewall, and in right foreground is sulphur stain and flow from an arch grout pipe. The average of 20 cross-sections of the tunnel covering the test section at 10 ft. intervals is shown in Fig. 2. This shows the average thickness of concrete and the probable extent of the void over the arch. The maximum thickness of concrete at the crown of the arch in the test section is 3.3 ft., minimum 2.0; average thickness under void, 2.8 ft. Of this thickness in the key, 10 ins. is of dense watertight concrete, mixed wet, above which is packed drier, more or less porous concrete.

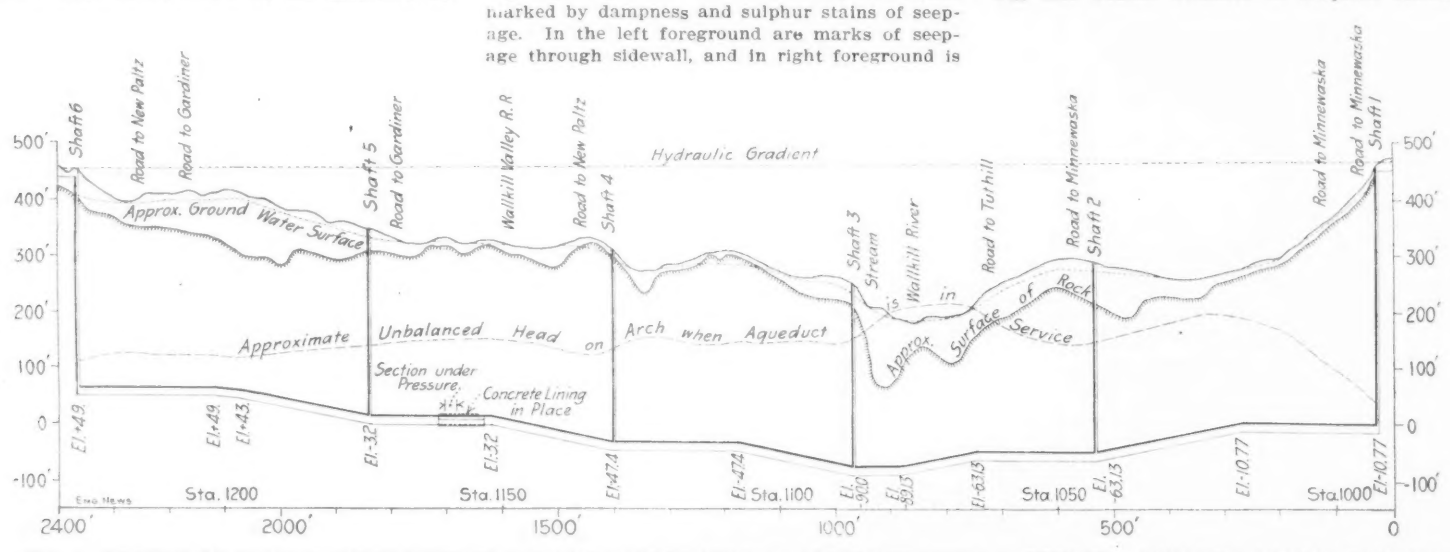

FIG. 1. PROFILE OF GROUNDWATER SURFACE AND UNBALANCED HEAD IN AQUEDUCT WHEN IN SERVICE. WALLKILL SIPHON, CATSKILL AQUEDUCT.

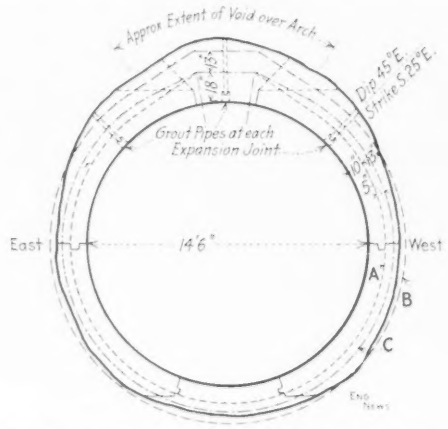

Fig. 2. Composite of 20 Sections in Portion of Wallkill Pressure Tunnel Under Test.

Test.

METHOD OF TEST.—This consisted of plugging all weepers and grout pipes in the tunnel lining and allowing first the ground-water to collect in the void over the arch and afterward pumping tunnel water through one of the arch pipes. This was necessary, as the escape of ground-water through rock seams to adjacent portions of the tunnel was sufficient to prevent a rise in head of more than 100 ft. The pressure over the arch was recorded on a steam gage attached to another arch pipe.

To confine a pressure to the void over the test section, the length tested was cut off from the adjoining lining by grouting at two low spots in the rock roof beyond each end of the section at 30-40 lbs. pressure, and later grouting between each pair of these cut-offs at 80-90 lbs. pressure, which was as high as could be had without the use of high-pressure compressors.

In closing the grout pipes in the arch, the void over the arch was shown to be continuous, as the full flow was encountered at different points throughout the section when one after another pipe was closed. Undoubtedly, the pressures registered by the gage later were constant throughout the 1,800 sq. ft. of void over the arch. There was also similar evidence of frequent connections through seams between the arch and the sidewall.

Brick dams were built on the invert about 15 ins. high at each end of the section for measuring the leakage.

DETAILS OF TEST.—The rise in pressure after closing all leaking grout pipes is shown in Table II. The pressure of the ground-water rose in three days to 40 lbs., at which pressure the leakage through the five cross-expansion joints in the arch had somewhat increased. The seepage through the body of the concrete had but slightly increased, and the only new indications of seepage were three small damp spots at key joints and two small spurting pinhole leaks in the sidewall, which later silted up and ceased to flow under the higher heads.

Without waiting for the ground-water pressure to rise higher, a connection was made from a grout pipe in the arch to the pump discharge at Shaft 5. In about half an hour the pressure rose to 80 lbs., and there remained stationary. The cross-expansion joints leaked from one to three gallons a minute each, the water entering the tunnel in jets and films. The marks of seepage on the concrete seemed slightly more moist in places, but no new seepage appeared.

After 14 hours at this pressure, it was necessary to shut off the connection with the pump discharge on account of a leaking water line. The pressure dropped to 30 lbs. when the connection was broken, but rose to 37 lbs. from ground-water in nine hours. This increased to 52 lbs. in seven days. The test section was again connected to the shaft line, and the pressure arose immediately to 102 lbs., and in 6 hours to 108 lbs. At this pressure, equal to hydrostatic head of 249 ft., there was no apparent increase in the amount of seepage through the body of the concrete. The leakage from the five cross-expansion joints in the arch amounted to 7 gals. per min.

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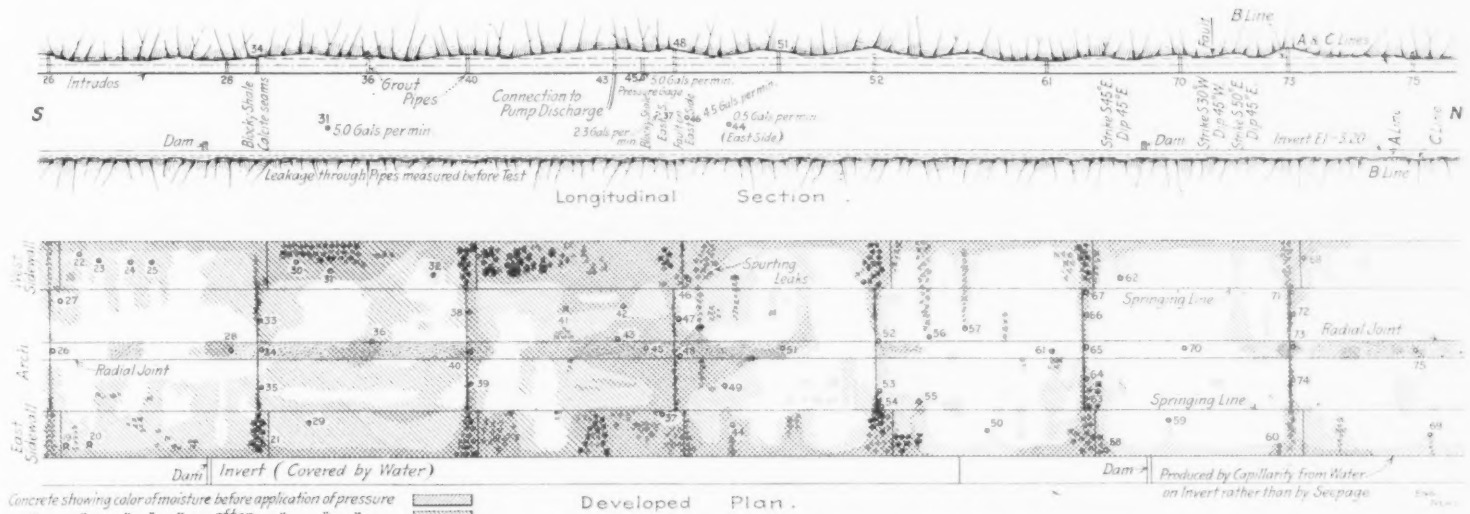

FIG. 3. PROFILE AND DEVELOPMENT OF TEST SECTION SHOWING EFFECT OF HIGH WATER-PRESSURE.

TABLE I—DETAILS OF NOMINAL 1 : 2 : 4 CONCRETE MIX USED IN TUNNEL LINING.

	Cement.	Sand.	Mortar.	Stone.
Bags	6	...	...	...
Cu. ft.	5.43	10.5	11.94	20.5
Proportions	1.00	1.93	...	3.77
Per cent. voids	...	38%	...	43%
Void volume, cu. ft.	...	3.99	...	8.82
Excess, cu. ft.	1.44	...	3.12	...
Per cent. excess to voids.	37.1	...	35.4	...
Total volume of mix	23.6 cu. ft.			
Cement factor	1.70 bbls. per cu. yd.			
Water	30.5 gals. or 7.1% by weight of dry materials.			
Water (dry concrete over key)	24 gals. or 5.6% by weight of dry materials.			

In eight days the pressure on the arch increased to 135 lbs., or hydrostatic head of 311 ft., equal to the average ground-water head on the siphon (310 ft.), and greater than the maximum unbalanced head in the tunnel when in service, 280 ft. (Fig. 1).

RESULTS OF TEST.—The leakage from the five cross-expansion joints had fallen to 1.4 gal.

TABLE II—RECORD OF PRESSURE ON GAGE.

Date.		Pressure lbs. per sq. in.	Hydrostatic head.	Remarks.
June 10,	Noon			Checked flow from grout pipes.
" 10,	3 P. M.	8	18	Test section not attached to pump discharge.
" 11,	3 P. M.	34	78	"
" 12,	10 A. M.	36	83	"
" 13,	4 P. M.	40	92	"
" 13,	6 P. M.	80	184	Attached to pump discharge.
" 14,	5 P. M.	37	85	Not attached to pump discharge.
" 15,	10 A. M.	40	92	"
" 16,	10 A. M.	42	97	"
" 17,	10 A. M.	47	108	"
" 18,	10 A. M.	49	113	"
" 19,	10 A. M.	50	116	"
" 20,	10 A. M.	50	116	"
" 21,	9 A. M.	52	120	"
" 21,	10 A. M.	102	236	Attached to pump discharge.
" 21,	4 P. M.	108	249	"
" 23,		112	258	"
" 24,	11 A. M.	120	277	"
" 25,	1 P. M.	123	284	"
" 26,	4 P. M.	126	291	"
" 28,	10 A. M.	131	302	"
" 29,	4 P. M.	135	312	"

per min. on account of silting up and cementation by the sulphur in the ground-water. The damp areas had increased somewhat, but the amount of water seeping through the body of the concrete was less than ½ gal. per min. The water from about 10 sq. ft., where the seepage through the sidewalls was worst, was carefully collected and found to be only about 0.3 gals. in an hour. A large part of the arch under pressure was entirely dry. The only seepage was at a few spots along the key joints, and only sufficient to cause infrequent drops to fall. These joints should be closed by the future arch grouting.

The above pressures and those given in the tables were maintained for about an hour and a half out of each two hours. During the other half hour it was necessary for the pump to stop running 20 mins., during which time the pressure on the gage at the test section fell gradually from 135 lbs. to 90 lbs. Upon starting the pump, the pressure would return to 135 lbs. in about 10 mins. The average pressure acting on the arch may therefore be considered to be approximately 4% lower than those shown by the gage while the pump was in operation. All observations and water measurements were made while the pump was in operation. The pump was an electrically operated turbine pump, which lowered the sump sufficiently to require to be shut down about 20 mins. in each two hours. The flow and pressure from the pump were constant while in operation, causing no hammer. The combined hydrostatic and friction head at the pump was

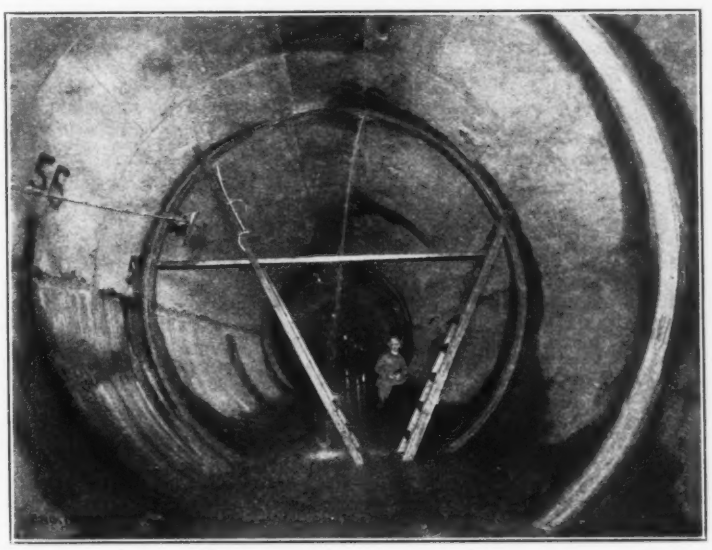

FIG. 4. VIEW OF TUNNEL SECTION BEFORE CHECKING FLOW FROM GROUT PIPES.

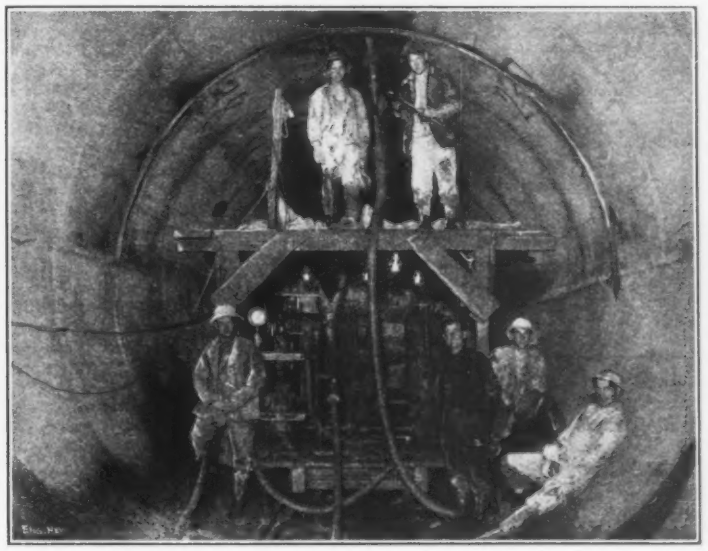

FIG. 5. VIEW OF CANNIFF GROUT TANK AT WORK IN CATSKILL AQUEDUCT.

TABLE III—LEAKAGE THROUGH CONCRETE AND EXPANSION JOINTS.

Time of Observation.	Pressure lbs. per sq. in.	Hydrostatic head.	Leakage five expansion joints.	Gals. per min. through concrete.	Remarks.
June 7, before closing grout pipes	..	..	0.5±	0.5±	Flow from grout pipes = 20 gals. per min.
June 10, 3 hrs. after closing grout pipes.	8	18	0.5±	0.5±	No increase in seepage.
June 11, 27 hrs. after closing grout pipes.	34	78	1.0±	0.5±	2 small spurting leaks appeared in sidewall.
June 21, 6 hrs. after attaching to pump..	108	239	7.0±	0.5±	Spurting leaks ceased to flow. All expansion joints leaking.
June 29, 8 days after attaching to pump..	135	311	1.4±	0.5±	Flow from expansion joints much reduced by silting. Damp areas on concrete somewhat increased.

370 ft. The difference in pressure at the pump and at the test section was due to escape of water from the test section into seams and past the cut-offs, which allowed considerable leakage into the adjoining arch after the pressure at the test section reached 100 lbs.

GENERAL CONCLUSIONS.—It may be safely concluded from the above that with reasonable care in mixing and placing of concrete, and with sufficient excess cement (see Table I), a concrete can be had which will be practically watertight against hydrostatic heads of several hundred feet. In case of tunnel lining proper, care in placing, of course, includes care in arrangement of collecting pans and weepers to carry leaking groundwater through the concrete and forms without damage to the body or finish of the concrete. Where small leaks may have been overlooked or a collecting pan fail to work, causing some slight seepage through the concrete, it would appear from the foregoing that even though the area of lining affected be considerable, the actual amount of water passing through would be small, and that such spots of seepage will grow less by silting up.

The leakage through cross-expansion joints will no doubt be stopped by grouting through arch pipes, which include three grout pipes at each expansion joint, as shown on Fig. 2. Any slight leakage from the expansion joints after grouting will probably be stopped later by silting. During the above test, with an increase in pressure from 108 lbs. to 135 lbs., in eight days, the leakage through five expansion joints decreased from 7 to 1.4 gal. per min. This same silting process has been frequently noticed in the material decrease of flow from a number of grout pipes.

Concrete Materials and Proportions.

The average of the reports of tests for strength and set of the giant Portland cement follows:

	Time of Set.		Tensile strength	Neat cement briquettes
	Initial.	Final.	7 days.	28 days.
Average...	5 hrs.	7½ hrs.	640 lbs.	710 lbs.
Maximum.	5¼ hrs.	8 hrs.	709 lbs.	787 lbs.
Minimum..	4¾ hrs.	6½ hrs.	555 lbs.	624 lbs.

The large aggregate was crushed Bonticou grit, a metamorphosed gravel, containing 43% voids. It was a well-graded aggregate of sizes up to 1¾ ins., from which all fines, including ¼-in., had been screened, excepting about 5% of the volume of the aggregate. The sand was a very clean, rather fine, bank sand. It was mixed with Bonticou grit screenings in proportions of 2 parts of sand to 1 part of screenings, proper allowance being made for the fines in the large aggregate. This gave a well-graded sand, containing 38% voids. The mechanical analysis curve is between the fine and medium sand curves of Taylor and Thompson.

The measurement of all materials was carefully inspected. Adjustable gaging irons were furnished by the contractor in the sand and stone hoppers, these being adjusted by the inspector according to results of screen analyses frequently made at the hoppers. Water was measured in a calibrated tank.

The mixer was an electrically operated 40-cu.-ft. mixer, making 16 turns a minute. Each batch was given 10 to 15 turns.

Hauling from the foot of the shaft to the forms was in three-car trains by electric motors. The concrete was dumped at the forms in less than a half hour after mixing.

Wet concrete was used over the entire arch to a depth of 10 ins. in the key, above which drier concrete was packed up to the rock roof. Before placing sidewall or arch concrete, the old work was covered with 2 or 3-ins. of wet 2:1 mortar, which insured watertight joints between invert, sidewall and arch.

The excavation of the Wallkill Pressure Tunnel was described in Engineering News, Oct. 20, 1910, p. 406.

The Catskill Aqueduct is being built by the Board of Water Supply, City of New York. Mr. J. Waldo Smith is Chief Engineer for the Board. The construction of the Wallkill Pressure Tunnel is being executed by the Degnon Contracting Co., of 60 Wall St., New York City.

Constructing a Deep Sewer of Brick and of Concrete-Lined Cast-Iron for the London County Council, England.*

By R. M. GLOYNE,† M. Inst. C. E.

This sewer forms part of the great scheme for increasing the drainage facilities of London, which is being carried out by the London County Council, on the advice, and under the direction, of the Chief Engineer, Maurice Fitzmaurice, M. Inst. C. E.

It passes through the boroughs of Battersea, Wandsworth, Lambeth, Camberwell, and Deptford, under Deptford Creek to the Deptford pumping-station, where the sewage will be pumped into the low-level outfall sewers which convey sewage to the Crossness Outfall Station.

The sewer now being constructed is, including connecting sewers, about eight miles in length, varies in diameter from 6 ft. to 8 ft., and is built, partly in brickwork, and partly in cast-iron rings, lined with blue bricks and concrete, practically the whole length being tunneled at depths from the surface to invert level varying from about 22 to about 70 ft. The gradients of the main sewer are 1 in 1,851 and 1 in 2,640.

Brick Section.

The brickwork portion, about 15,950 ft. in length, consists of two rings of wire-cut rough red bricks, and one ring of pressed bricks, the lower half of the inner ring being of pressed blue, and the upper half of pressed red bricks.

This work was tunneled through the London clay, from shafts sunk at intervals by the usual method of short headings in advance of the length, afterwards enlarged to the proper diameter.

The working shafts on the brickwork portion of the main sewer were excavated and timbered in the usual manner, and were later on converted into permanent manholes or side entrances.

The timbering of the lengths, which measured 7½ ft., consisted of 7-in. diameter larch bars, and 1½-in. poling boads, with the necessary sills, props, etc. All bars were removed, and the space between the back of the outside ring of the sewer and the poling boards, where these were left in, or the clay, where the boards were removed, was packed solid with brickwork in cement.

The rate of progress on the brickwork sewer was excellent, one length per day per face, or 90 ft. per week at each pit being regularly built week after week.

Cast-Iron Section and Use of Shield.

The ironwork portion of the sewer, about 26,200 ft. long, consists of cast-iron rings ⅞-in. thick, lined with fine concrete, the invert and up to springing being of pressed blue bricks; each ring is made up of six segments and a key piece with internal flanges 6 ins. deep by 1¼ ins. thick, and ⅞-in. stiffeners, and measures 21 ins. in length. The rings vary in external diameter from 9 ft. 4 ins. to 9 ft. 10 ins., and form a completed sewer when lined of 7 ft. 6 ins. and 8 ft. diameter, respectively. The greater part of this length is constructed with the help of shields, through water-bearing gravel and sand, and under compressed air. The working shafts on the ironwork portion are of cast-iron cylinders, 20 ft. and 16 ft. 11 ins. in external diameter, made up of rings 4 ft. in depth, each ring consisting of twelve segments. The bottom ring of all was furnished with a cutting edge, and the method of sinking was to erect the cutting edge ring, after excavating for a few feet from ground level, and then by continually excavating from inside the shaft and adding fresh rings to sink the shaft to water level. On getting down to water level an air-tight iron floor was fixed in the shaft with an air lock, and further excavation proceeded with under compressed air. The necessary air compressing plant is installed at three of the working shafts.

The shields were constructed by Markham & Co., of Chesterfield, and are 1 in. larger in diameter than the outside diameter of the cast-iron rings. They are pushed forward by hydraulic pressure acting on any, or all, of the eight rams, 7 ins. in diameter, with which each is fitted. By this individual control of each ram, corrections can be made, if necessary, in either line or level, and the shield driven accurately round curves. The pressure is obtained by taking water from the ordinary water mains in the streets and leading it to a Hayward-Tyler air-driven hydraulic pumps mounted on a tank on wheels, which is drawn ahead by the shield as it advances. The air cylinder of this pump is double-acting and 7 ins. in diameter, the ends of the 1-in. piston rod forming the plungers for the hydraulic force pumps. The air is admitted to the air cylinder at about 60 lbs. per sq. in., the hydraulic pressure being transmitted from the force pump to the shield rams at about 2,940 lbs. per sq. in. When all the rams are working the pressure exerted is over 400 tons [of 2,240 lbs.].

The method of working in the water-bearing sand and ballast is as follows: The face of the tunnel is well covered with pug, close boarded and strutted, to prevent falls of the soil, and, as far as possible, the escape of the compressed air; and portion of the ballast and sand opposite and all round the cutting edge of the shield is taken out in pockets to a depth of some 24 ins. and extending to about 3 ins. outside the circumference of the cutting edge of the shield, the pockets being filled in with clay, well rammed in, so that the cutting edge, when the shield is driven forward, penetrates the clay, a "blanket" of which is left over the shield as the latter moves forward, thus preventing, to a great extent, any escape of air at the tail of the shield.

The hydraulic rams which actuate the shield bear against wood packing placed between them and the last cast-iron ring erected, and push the shield forward into the face sufficiently far to enable one ring to be put in under cover of the shield. Before this ring is put in, however, the previously erected one is "grouted up," the annular space between the outside of the iron and the ground surrounding it being filled with liquid lime grout forced in, under a pressure of about 60 lbs. per sq. in., through the holes left in the cast-iron ring segments for that purpose. For grouting, each ring requires about 2½ bags of lime. The hydraulic rams are then drawn into their cylinders and the next ring erected. This being done, the face of the tunnel is once more attacked, the horizontal face boards being taken down two at a time, and, on the ground being excavated, put into their fresh position 21 ins. further ahead, and temporarily strutted from the shield until such time as the whole of the face is advanced, when "soldiers" are erected, bearing against all the face boards, and strutted back to a completed tunnel ring, the temporary struts being then knocked out and the shield pushed forward once more over the timber face.

Up to the present time the air pressure required has not been more than from 5 to 6 lbs., but while passing under Deptford Creek, which is subject to the influence of the tide, a considerably greater pressure will no doubt be required. At high water there will be a difference between the water level in the Creek and the invert of the sewer of about 30½ ft.

The progress in this part of the work is also excellent, an average of from six to seven rings being erected in 24 hours at each face. To ensure water tightness the flanges of all segments are machined except for a space 1 in. in depth on the inside where the iron is ⅛-in. less in thickness than the flange. When two segments are bolted together there is therefore a space 1 in. deep by ¼-in. wide, forming a groove which is calked with lead wire and with iron filings and sal ammoniac, the latter making an efficient rust joint. The bolt holes are made watertight by yarn grummets well soaked in red lead, which are squeezed into them under the iron washers placed on the bolts at each end, while the grout holes, besides being sealed by the grout, are furnished with yarn grummets and screw plugs.

The whole of the plant at these shafts is worked electrically, the materials being handled on the surface and lowered down the pits by 3-ton electric locomotive cranes, and hauled along the tunnels by an 8-HP. electric lomomotive.

The tunnels are lighted by electric light, and telephonic communication is available between the men working in the compressed air and those at the shafts outside the air-lock.

Large cast-iron penstocks and timber dams are provided at all the main connections so that the flow of sewage can be controlled in either the existing or new sewers.

Work was commenced in January, 1910, the time limit being three years.

The Author, as District Engineer, is in charge of the work, under the direction of the Chief Engineer, and Mr. J. P. Harris is the Resident Engineer.

*A slight condensation of a paper read before the Institution of Municipal and County Engineers, at the Metropolitan District Meeting, held at Battersea (London), Oct. 21, 1911. The original title of the paper was: "Notes on the Construction of the New Main Low Level Sewer for the South Side of London, from Battersea to Deptford."

†District Engineer, London County Council, London, England.

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The Dredge for the Imperial Valley Canal.

Irrigation engineers will follow with interest the article by Mr. F. C. Finkle (published elsewhere in this issue), describing the dredge built to remove silt from the Imperial Valley canal. The disposal of the silt brought down by sediment-carrying streams is one of the most difficult problems which the irrigation engineer has to face. Those of our readers who have followed the situation on the Imperial Valley are aware that the difficulties with silt on the one hand, and erosion on the other, have taxed the best efforts of the irrigation engineers.

How dangerous was the situation of the Imperial Valley farmers may be judged from Mr. Finkle's statement that had the silt in the canal not been removed by the dredge, it would have been impossible for the canal to have carried sufficient water down to the Imperial Valley farms to have saved the crops of last season. The successful completion and operation of the dredge, therefore, saved crops valued at several million dollars and also avoided a general destruction of property values throughout the Imperial Valley.

While there are few irrigation districts where silt deposits are as troublesome as in the Colorado delta, there are doubtless many other places where hydraulic dredging in irrigation canals can profitably be adopted.

Against Government Bureau Competition With Mining Engineers.

The recent discussion in these columns concerning the offer of a Government Bureau of Engineering to do free engineering work, makes of special interest the action recently taken by members of the mining engineering profession.

The Council of the Mining and Metallurgical Society of America at its meeting on November 27 had before it a draft of a proposed bill to establish a Bureau of Mines in the Department of the Interior. While this Bureau is already in operation, it is desired to have a law enacted by which the Bureau may be placed upon a permanent basis. The proposed bill has already been discussed by the Philadelphia, New York and San Francisco Sections of the Society. At the Council meeting on Nov. 27 a draft was adopted in which the following principles were incorporated: (a) That government encroachment upon private enterprises should be prevented by the organic law. (b) That the engagement in private work by employees of the Bureau of Mines should be prohibited by the law.

The draft of the bill presented by the Council contains the following in section 4:

> Nothing in this act shall be construed as granting to the Bureau of Mines any right or authority to undertake any investigation in behalf of any individual person, partnership, corporation, or association, except for the help and safety of persons employed in the mining, quarrying and metallurgical industries.
>
> Section 5. No person regularly employed by the Bureau of Mines shall be permitted to undertake special engagements or accept employment for compensation from any person, association of persons, or corporation, nor shall the Bureau of Mines detail any such regular employes to perform such service, except as above stated.

A provision is added to the effect that a person employed solely in a consulting capacity by the Bureau shall not be included in the above prohibition.

It should be understood that these restrictions in the law were not made by way of criticism upon the present or past conduct of the Bureau of Mines. It was simply recognized that there were possibilities of such a Bureau undertaking work which would compete unfairly with the work of consulting mining engineers, and it was deemed proper to embody in the law the above restriction.

The Flood in the Cedar River, Washington.

The breakage last month of the conduit supplying the city of Seattle, Wash., with water was a disaster of greater potential danger than any that has taken place to any large city's water-supply since the flood which wrecked Kansas City's water-supply system in 1903. Seattle was fortunate in having a reasonable amount of water in storage, sufficient to last the city for nearly a week. This gave sufficient time for the engineers by working night and day to restore the broken conduit before the reservoirs were emptied. Emergency pumping plants were also brought into action and materially supplemented the supply in the reservoirs. It is noteworthy that the conduit supplying Seattle is to be so altered that it will nowhere cross the Cedar River by a bridge and will therefore be free from damage of breakage by such a flood as that just recorded.

The phenomenal rate of discharge attained by the Cedar River in the November flood is worth special attention. As stated in the article elsewhere in this issue by Mr. Geo. Holmes Moore, a maximum rate of 120 cu. ft. per second per square mile of drainage area was reached, the watershed above the point of measurement having an area of 79 square miles. This phenomenal run-off was the result of a heavy rainfall combined with the melting of a heavy fall of light snow by a warm Chinook wind.

The Defects of Bituminous Macadam Roads for Horse Traction.

The perfect bituminous macadam road to resist automobile wear, is very far from perfect for the needs of horse traction, as it is too slippery to give the horse a secure foothold, particularly in wet or freezing weather. Mr. C. Gordon Reel, Assoc. M. Am. Soc. C. E., State Superintendent of Highways of New York, is quoted as follows:

> Complaints come into our office daily about roads built for farmers' use, which are so slippery that the people have to either drive through the fields or scramble along the shoulders of the roads the best way they can, and strange as it may seem, a much cheaper kind of road would have been entirely satisfactory and serviceable.

The task of satisfying everybody is one at which not even a road engineer can succeed. Where a road is chiefly used by horse-drawn vehicles, however, and motor traffic is small, it would seem wise to postpone the use of bituminous macadam until the motor traffic causes wear enough to compel a change.

The Outlook in the Coal Mining Industry.

It is a truism to say that all industrial operations are to-day dependent on coal. Cut off the supply of coal to a city or a state and within a few days factories begin to shut down, power plants have to stop, electric lights are cut off, and street cars cease running. If the famine continues, the regular railway service must stop, business of all sorts is totally paralyzed, households suffer from cold and from hunger as well, for the food supply of every great city is dependent on the constant daily influx by rail.

At the recent meeting of the American Mining Congress, Mr. D. W. Kuhn made the prediction that unless combinations are effected among soft coal mine operators enabling them to eliminate the present severe competition and advance the price of coal, next spring will see a forced reduction in coal miners' wages and a consequent universal coal miners' strike which will bring about the greatest paralysis of industry ever known in this country.

We print some extracts from Mr. Kuhn's paper elsewhere in this issue so that our readers may judge for themselves how much weight should be given to his plea for consolidation in the coal mining industry and to his prophecy of an impending coal strike.

We sincerely hope that the danger of a general strike among coal miners is much less serious than Mr. Kuhn intimates. That there is general dissatisfaction in the coal mining industry, however, and that the smaller operators, at least in the coal fields of the Central West, have been working on extremely low margins is a matter which is generally known.

In the East, also, next spring comes the expiration of the agreement between the anthracite operators and the miners. Each side is "sparring for position" preparatory to the making of a new agreement, and there is at least the possibility that instead of a peaceful renewal of the agreement, a dead-lock and long warfare may result, such as caused such a great amount of loss and suffering nine years ago.

With such possibilities impending, every prudent user of coal will see to it that his stock of coal on hand is kept up to the limit of capacity during the next few months, and in not a few cases emergency supplies will doubtless be placed in stock as an insurance against possible famine.

It must be recognized, however, that in the case of soft coal especially, only a small percentage of the annual output can possibly be stored. Most large consumers of coal have to live from hand to mouth. Interruption of coal output and shipments for even a few days is bound to put many consumers of coal in serious straits. A general coal strike, therefore, threatens public welfare to a greater extent probably than a strike in any other industry. If there is danger of such a disastrous event, all possible means ought to be taken to avert it.

Mr. Kuhn's recipe for averting a strike is as follows: He would have all the mine operators in a given coal field combine, avowedly to limit the present competition with each other and to raise the price of coal. With this done, the reduction in miners' wages would no longer be necessary, and any just concessions which the miners might demand could be granted.

Against such combinations to restrict competition stands the Sherman law with its penalties of fine and imprisonment and its standing offer of three-fold damages to any person who can prove that he has suffered loss through operation of any combination in restraint of trade.

Mr. Kuhn thinks, therefore, that the Sherman law ought to be so amended as to permit his particular combination. He is not alone in that belief. A very large number of people want to have the Sherman law so amended that it will not apply to their particular form of combination. Their desire is natural enough; but in this case it is a very far cry from desire to gratification.

In the present state of public opinion and with the present well-known temper of Congress and of the President, there is about as much chance of the Sherman law being amended this winter to be more gentle toward combinations

as there is of a distinguished Wall Street financier being elected President of the United States. If Congress does anything at all to the Sherman law it will probably add to it some long and sharp teeth.

Nor is this attitude of the public quite so unreasonable as Mr. Kuhn and other business men who are "up against it" may think. Suppose that all the soft coal operators in a district do combine and raise the selling price of coal? If they would only raise the price enough to cover the cost of fair wages to miners, provision for compensation to those suffering from mine accidents and such apparatus and equipment as shall permit the mine to be operated with due regard to safety and to economical mining, securing as nearly as possible the entire contents of the vein—if they would do only so much there might be no serious fault found. But what body of men—be it labor union or a combination of capital—can be given a clear monopoly of production in a given field with assurance that they will not use their power to take a little—or a good deal—more than their fair share of profit? And what is there anyway except competition to determine what their fair share is?

So far as combination to secure economies by large scale production are concerned, the recent court decisions on the Sherman law do not indicate that such combinations are prohibited by it. If, therefore, Mr. Kuhn's recipe is really as good as he claims, there is nothing to hinder a half-dozen or dozen of the best coal operators in a district forming a combination—not an agreement to fix prices, but an actual consolidation.

If such a concern does not water its stock, does not take advantage of its size and strength to compete unfairly with other mine operators and seeks profits by introducing the best methods of mine management and operation, with reduction in the cost of selling and transportation—if such methods were pursued, it does not seem at all likely that such a consolidation would be held to be restraining trade under the Sherman law.

As far as the smaller and poorer mines are concerned their inclusion in any such combination would weaken rather than strengthen it. It is better to leave them alone to survive or not as they can. Their potential competition is a safeguard to the public against the charge of excessive prices by the combination; and usually the prices at which they can barely survive should be enough to yield fair profits to a mining company large enough (but not too large) for economical administration.

It is entirely true, as Mr. Kuhn emphatically declares, that coal will be wastefully mined so long as mine operators are working their mines at less than a living profit. Stress of competition does tend to make the mine operator skim off the cream and leave the rest in order to keep from bankruptcy. Small operators cannot command the capital or the skill to provide for the distant future. But there is no chance of driving the small operator out of the coal mining business, and it would be doubtful public policy to do so.

What should be done is to compel, by state legislation, economical utilization of the coal. The state inspection to secure the safety of operatives—to conserve human life—ought also to see that as much as possible of the entire coal in the seam is saved. A law to compel such economical use of coal seams would of itself restrict the entry of inexperienced and ill-equipped concerns in the coal mining business, and ought therefore to be favored by all coal operators who desire to see the industry placed on a sound basis.

Conservation means, of course, not the mere hoarding of mineral or other gifts of nature for future generations. Our present industries require an enormous consumption of coal and metals. What conservation requires is that waste shall be stopped at every point so that our inroads upon the limited stores available for the race may be as small as possible. It is well known that the waste common in soft coal mining has been in the past little short of criminal.

LETTERS TO THE EDITOR.

Sewer Outlets at Chicago, in Relation to the Possible Pollution of Lake Michigan.

Sir: In your editorial on the "Approaching Legal and Physical Limits to Sewage Disposal by Dilution at Chicago" (p. 661, Nov. 30, 1911) you refer to the 156 sewer outlets in Chicago, and infer that at times of storm all may discharge into Lake Michigan. The situation is this. No sewer outlet to-day enters Lake Michigan or can discharge therein at time of storm, directly. The sewers discharging into the Chicago River might indirectly discharge into Lake Michigan by reversing the flow of the main river. This is a possibility, but not a probability, as it would take a run-off of 44.4 cu. ft. per sec. per sq. mi. over an area of 180 sq. mi. in order to exceed the present capacity of the South Branch. This is very unlikely to occur.

In the Calumet region all the sewers enter the Calumet River, and at present whenever the river discharges, the sewage and sludge are swept into the lake. Since the flood flow of the Calumet is so greatly in excess of the capacity of the Calumet Sag canal under construction, we have urged the construction of intercepting sewers to keep all the dry weather flow, and a large portion of the storm flow out of the river.

As regards the necessity for the filtration of the entire water-supply of Chicago, I would point out that the present typhoid death rate varies from 11 to 14 per 100,000. This is fairly low compared with many of the lake cities, although high alongside Berlin or London. Personally I believe that the demand will come with rising sanitary standards, partly to insure a water always clear, and partly to have a supply above all suspicion of bacterial pollution. The situation requires thorough study and far more detailed observations of the water than have been made heretofore.

Langdon Pearse,
Assistant Engineer, The Sanitary District of Chicago.

American Trust Building, Chicago, Ill., Dec. 2, 1911.

The Popular Idea of Engineering: The Eye-Bar Chain Suspension Bridge.

Sir: The subscription price of Engineering News is a very small price to pay for such valuable reading matter as came out in two recent editions of Engineering News: the contributions by Mr. Gustav Lindenthal on the Quebec Bridge Design. His papers emphasize the fact that commercializing of engineering work is the cause of many failures which are attributed to lack of ability or carelessness, or both.

In America, however, it seems to be a part of the duty of the heads of departments of large concerns to impress upon the minds of their subordinates what an insignificant part of the organization each of them is, and it matters not whether he is the draftsman who designs new mills or the Italian who excavates for their foundations.

The relative position of an engineer in America and in Germany was illustrated a few months ago at the Ensley, Ala., Steel Works of the U. S. Steel Corporation. When pay day rolls around the drafting force below chief draftsman have to get in line with the office force of nine clerks and file through the pay car just like the Negro and Italian laborers. There happened to be a German who had just been put on the force and he balked at the idea of standing in line in the rain to wait for his month's salary, and made emphatic remarks as to what would happen in Germany if one of the mills should subject its engineering force to such humiliation.

A few years ago I was leveler for the Southern Railway on location work and stopped at a boarding house in Sheffield, Ala. The landlady wished to know what kind of work I did. To make a short answer, and without regard for the requirements necessary for one to bear the title conscientiously, I told her I was a civil engineer. She intimated in a polite way that I occupied a very small place in life, compared with her son, for he was locomotive engineer, a stationary engineer, a hoisting engineer and a civil engineer too!

One more word in praise of Mr. Lindenthal's work. One doesn't have to be an authority on long-span bridge construction to appreciate the advantage Mr. Lindenthal's design of a trussed chain or stiff chain suspension span has over the cantilever type. This brings in one of the first principles that a designer should know: the cheapest way to work steel is in trusses; next to that is compression, and the most expensive of all is in flexure.

R. T. Bagley,
1219 St. Ann St., Owensboro, Ky., Dec. 4, 1911.

More Concerning Federal Supervision of Dam Construction.

Sir: In your issue of Nov. 9, 1911, Mr. S. D. Newton, Assoc. M. Am. Soc. C. E., while admitting the probable authority of the United States over the construction and operation of dams on the headwaters of navigable streams, does not approve of stretching Paragraph 3 of Section 8 of Article 1 of the Federal Constitution beyond what he considers the elastic limit by a too-liberal interpretation of that clause of the Constitution.

The "Fathers" wrote a Constitution which is a model for democracies, but which was nevertheless framed to meet political and economic conditions which they knew. They could not possibly have foreseen the complex conditions of to-day. Fortunately, however, they inserted the interstate commerce clause, and its broad and liberal interpretation has provided a safety-valve to prevent the "blowing up" of our Ship of State, while the "purposely cumbersome" amendment machinery is being set in motion to relieve the pressure.

Constitutions, like theologies, morals, ethics, languages, and other man-made institutions, cannot escape the action of the laws of evolution, and if they are to survive as living forces, their elastic limits must equal infinity.

The writer's suggestion that the United States control dams upon the headwaters of navigable streams was intended, of course, to apply only to streams lying wholly within the boundaries of the United States, Alaska, and our insular possessions. Control of dams on international streams is a matter for international agreement.

It was the late A. M. Wellington, M. Am. Soc. C. E., the writer believes, who said: "An engineer is one who can do **well** with one dollar, that which any bungler can do with two after a fashion." If the word **well** be omitted, the revised definition will describe the attitude of some promoters toward the engineer and toward the public safety with the result that the engineer sometimes suffers in the loss of professional reputation, and the public in the loss of life and property. This is especially true of the design and construction of large dams.

At present, there appears to be no efficient supervision or control of power dams being built upon many streams in the United States, except those on navigable streams, now in operation or being built under Congressional authority, which carries with it the provision that their construction and operation shall be under the supervision of the army engineers.

Why not, then, invoke Congressional sanction for dams on the headwaters of navigable streams, and thus further protect the interests of navigation, which Congress has clearly the constitutional power to do, and, incidentally, protect the lives and property of those living in the valleys below them?

D. M. Andrews,
M. Am. Soc. C. E.

Rome, Ga., Nov. 24, 1911.

The Need of Judicial Fairness in Engineering Investigations.

Sir: A wave of reform has recently been sweeping over the country. Reforms are signs of progress and are, therefore, legitimate. It is the unpleasant results coming from a grasping of the shadow of reforms and missing the substance that should call for condemnation. The wave of reform referred to has not spared the domain of the engineer. It has reached his field through state investigations of public works.

As one who has been closely associated as a representative of the unpopular side in one of these many investigations engineered in behalf of civic righteousness, the extent to which an honest and sincere engineer can be misrepresented has been most strongly brought home to me.

The investigation to which I refer took place in one of the thriving cities of the Middle West. After proceeding through many city departments it finally reached the engineering department. The progress of this investigation was watched very closely by the public through the medium of an obliging press and it was necessary that the press should have something to print as well as that there be in the meantime some capi-

al in the way of reputation for the moving spirits of the investigation.

The investigation finally reached the work of a certain contractor and engineer whom I have had the honor to serve. This man's ability as an engineer needs no defence. Evidence of his genius in one particular line of work can be found from the Rocky Mountains to the Atlantic Ocean. Now like most engineers who did work for the state, he desired to make money. Yet as an engineer who respected his profession, it might be said that he worked almost as much for the love of the work as for any other one thing. His company through long years of hard and successful work had won an enviable position in its particular field and, therefore, during the entire ordeal of the investigation the contractor's main efforts were in the direction of defending the reputation of his company from any false representation.

During this investigation the contractor and engineer had the writer as his representative accompany the engineers who represented the state and it became clear to the writer that these state servants were not well equipped either in training or by the experience that would fit them for this particular investigation. In one particular instance, the desire to make a reputation at the expense of the true scientific spirit was evident in one of the chief investigators. This, however, was not the climax. This came at the public hearing when the state officers, in the role of both judge and jury, gave scant courtesy to whatever was favorable to the contractor.

Chas. S. Duke.

315 No. Park St., Madison, Wis., Nov. 27, 1911.

More Light on the Collision of the "Olympic" and the "Hawke."

Sir: In your editorial discussion of the collision of the "Olympic" and the "Hawke" (Eng. News, Nov. 23, 1911) you quote a paper by Naval Constructor D. W. Taylor, U. S. N., on reactions of vessels under way. The paper was, according to your article, founded on experiments with models that were towed in pairs at definite fixed relative positions. I have not had the privilege of reading Mr. Taylor's paper. It is doubtless interesting and instructive, and if the information it contained had been fully disseminated among the navigators of the world it is not likely that the "Olympic" would have been rammed by the "Hawke." I think it will occur to most engineers, however, that the reactions—apparent attractions and repulsions—between pairs of vessels under tow might be entirely different from those reactions between vessels under way by their own motive power.

The propellers of a modern large vessel are constantly sending astern great quantities of water. This water must come from forward of the propellers and the result is that the vessel is constantly progressing in a surface depression which progresses with the vessel. Within this depression there is a current setting toward the propellers. The prow of another vessel pushed into this current must inevitably receive an acceleration toward the bottom of the depression. That is the general condition; of course the movement of the water is complicated by the wave at the prow and the water that tends to follow in the wake, etc.

Some years ago the writer had occasion to make several trips by river boat between Portland and Astoria, Oregon. Part of the route lay through certain deep narrow sloughs connecting at both ends with the Columbia River. The sloughs were about 150 ft. to 350 ft. wide, the boat say 200 ft. long. I repeatedly observed the following action of the water surface gaged by logs or other objects at or near the shore: At a point about 100 ft. ahead of the bow of the boat the water began slowly to settle, and this settlement continued until the point had come about opposite the center of the boat or three-fourths her length from the prow, when the depression would amount to a foot or more. The water then began to rise and continued to rise slowly until caught by the direct waves of the boat.

The depression shown in a narrow slough would, of course, be greater, relatively, than would occur in open water, but after seeing what I have described, the accident to the "Olympic" seems easy to explain. The action of water in the vicinity of a moving boat is interesting to a landsman, and should be so to a seafaring man. The depression may be observed whenever in still water a vessel under way passes near a pier or other fixed object.

R. H. Britt.

Rockland, Me., P. O. Box 55, Nov. 28, 1911.

A Simple Method of Deriving the Formula for Mallet Locomotive Coupling Pins.

Sir: Referring to Mr. Weaver's letter in Eng. News Sept. 28, p. 375, the writer would say, that if mechanical engineers and locomotive designers would use the chord of half the angle and right-angle triangles instead of full chords and

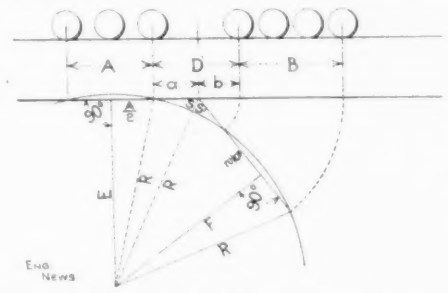


Diagram for Derivation of Coupling-Pin Formula by Mr. Arkin's Method.

other triangles, their calculations would be much simplified.

Let A = rigid wheel-base of front unit.
B = rigid wheel-base of back unit.
D = space between the two wheel-bases.
E = center of curve to middle of A.
F = center of curve to middle of B.
a and b = the distances from the coupling pin to the respective wheel-bases.
s = distance from the circumference to the coupling pin of the front unit.
s^1 = distances from the circumference to the coupling pin in the back unit.
R = any radius.

From R and $\frac{A}{2}$ solve E; from R and $\frac{B}{2}$ solve F.

Assume any practical figure for a; then from E and $\frac{A}{2} + a$ solve the hypotenuse $R + s$. Finally, from F and $R + s$ solve for $\frac{B}{2} + b$.

Take a numerical example: Let R = 1,000 ft., A = 10 ft., B = 14 ft. and a = 4 ft.; then b = 3.247 ft. and s or s^1 = .028 ft. But if b should be made 4 ft. or equal to a then s^1 would be .036 ft. and the difference, $s^1 - s$, would be .008 ft. for a radius of a 1,000-ft. or .080-ft. for a radius of a 100-ft.

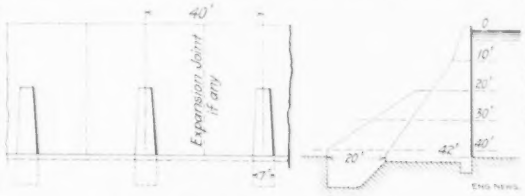
S. Arkin.

Topographical Bureau, Borough of the Bronx, New York City, Oct. 4, 1911.

Buttresses for Low Masonry Dams.

Sir: Several of the best engineers in the dam business have of late had something to say in your paper about the recent dam failures which have taken place, and especially about the remedy of the faults and the prevention of such failures in the future. One remedy which could be applied to such cases as the Austin dam has not been mentioned, and, as it is a comparatively cheap method of strengthening solid masonry dams less than 50 ft. high, and also easy of application, it should be taken into consideration, besides other methods, whenever it is found necessary to strengthen an existing solid masonry dam.

The Austin, Pa., dam slid (and so did many others) and shoved a slice of rock in front of itself downstream. Judging from the pictures and



Buttressing Low Masonry Dams.

drawings given in Engineering News, this slice of rock could not be over a few feet thick, as the bottom of the dam was only a few feet below the top of the rock. Suppose buttresses had been added on the down stream side 30 or 40 ft. apart and these buttresses carried down 10 ft. or more, the water pressure would now have had to move a slice of rock 10 ft. thick or more, instead of a slice only about 2 ft. thick, before the dam could fail. If this thickness of the buttresses at point of greatest stress is made one-sixth of the distance between center of buttresses, the dam body would have strength enough acting as a beam between the buttresses to transmit the greatest part of the water pressure to the buttresses, should there be a tendency to slide on the foundation.

With the water standing 42 ft. above the bottom, the resulting water pressure per running ft. will be 55,125 lbs. If the spacing of buttresses is 40 ft. c. to c. (see sketch), each buttress will have to stand a shear of $40 \times 55.125 = 2{,}205{,}000$ lbs. at elevation 42, which coincides with the top of the rock. If the thickness of the buttress is made 7 ft. and the length in an up and down stream direction 20 ft., at elevation 42, the shearing stress will be $\frac{2{,}205{,}000}{7 \times 20} = 15{,}700$ lbs. per sq. ft. Should this be considered somewhat high, steel can be put in to help out, but it must be remembered that this is the highest value the shear stress can possibly reach and that this value will in all probability be less than half.

The addition of the buttresses greatly increases the effective width of the dam, thereby increasing the stability to overturning. Some of the compression at the toe of the dam is transferred to the buttresses and these will be highly compressed in a horizontal plane at deeper elevations, thus limiting this method of strengthening dams to structures 50 ft. and less in height. But, according to Mr. Wegmann's articles in Engineering News of Nov. 16, it is just that size of dams that has failed most frequently in the past. It is true that on a poor foundation the solid masonry dam has no place, but some such construction as the Ambursen type should be substituted. If the dam is built, however, and the question comes up how to strengthen it before it fails, a system of buttresses on the down stream face for reinforcing, like a retaining wall, is an economical solution for dams 50 ft. in height or less.

Lars Yorgensen.

Chronicle Building, San Francisco, Nov. 23, 1911.

[Buttresses might have saved the Austin dam from sliding, but they could not have prevented the escape of water through the open strata beneath the dam. This escaping water would eventually have undermined the foundations and have caused unequal settlement and breakage of the structure.—Ed.]

The Free Bridge Engineering Offer By the Office of Public Roads.

Sir: After reading the various letters, pro and con, which refer to your editorial of Nov. 16, on Bulletin No. 39, of the Office of Public Roads, I feel that you were quite justified in your stand. The fact that the wording of this Bulletin was so framed as to compel a wrong interpretation should not be laid to you; and in any case, I believe you have sounded a useful warning against further Governmental aggression on the rights of the engineer in private practice.

Very truly yours,

F. S. Tainter.

Hoboken, N. J., Dec. 8, 1911.

Notes and Queries.

R. J. Z., Spokane, Wash., writes:

Recently in Engineering News there has been considerable discussion concerning failure of dams, giving the general geology of the sites, what caused the failures, etc. This is all good and valuable and a thing every engineer interested in hydraulic-development ought to want to hear about; but so far there has been few suggestions as to guarding against the failure of dams, by sliding on their base, because of water pressure under the base of the dam. Why not adopt a drainage system to relieve the pressure of water underneath the dam?

It was announced, at the recent annual meeting of the American Society of Mechanical Engineers before which the paper of Dr. D. S. Jacobus on "Tests of Large Boilers at Detroit" was presented, that several changes had been made in the tabulated data of results. This paper was abstracted in Engineering News, Dec. 7, and the following changes are to be noted: Test No. 16, per cent. ash in dry coal, from 9.68 to 9.30; Tests Nos. 2-4, efficiency, from 86.13 to 76.13; Test No. 14, per cent. rating, from 185.2 to 185.5; Test No. 7-9, per cent. combustible in ash, from 29.9 to 30.0.

The Uses of the Great Lakes.*

By GARDNER S. WILLIAMS,† M. Am. Soc. C. E.

The most commonly thought of use to which the waters of the Great Lakes have thus far been put has been in the transportation of freight. Since the days of the French voyageurs, the lakes and their connecting waters have formed a great highway of travel and commerce that early established the lines of foreign conquest, and later of national development. To aid commerce on the lakes more than $25,000,000 have been spent in deepening and improving channels in the Upper Lakes and their connecting waters, not to mention the expenditures for lighthouses, beacons and buoys, and the deepening of harbors.

While the purpose of these improvements has been to provide deeper channels for the passage of vessels, the work has frequently proved an example of robbing Peter to pay Paul; for as sure as a channel has been deepened the flow through it has been increased, with the result that the waters above it have been lowered and frequently dredging has been necessary to maintain the former depths. The most striking instance of this is at the St. Mary's Falls Canal, where the improvements of the channels toward Lake Huron have so lowered the water at the locks that the possible draft of ships passing has already been reduced between one and two feet, and the end is not yet.

Probably the most important change on the lakes is that which has been produced on Lake Michigan as a result of the improvements in the Detroit and St. Clair Rivers and through Lake St. Clair, the effects of which have been variously attributed to deficient precipitation, excessive evaporation, the cutting of forests and the Chicago Drainage Canal diversion.

Until 1888 the channels connecting the Great Lakes were in substantially a state of nature, except for the St. Clair Flats canal, opened in 1874, through the delta of the St. Clair River, and the uncompleted Limekiln Channel near the mouth of the Detroit River, which was begun in 1876 and the first cut (300 ft. wide) opened through in 1888, the channel being finally completed in 1891. Simultaneously with the opening of the Limekiln Channel in 1889 a fall was noticeable in the relative elevation of Lakes Huron and Erie, and in the six years, 1890-1895, the mean elevations of the surfaces of these lakes were 0.58-ft. nearer together than during the period 1860-89 inclusive, and 0.27-ft. nearer than during any six-year period in that time.

From 1896 to 1906 the lakes remained in nearly the same relative position, but during the four years, 1907-10, they have approached each other 0.22-ft. more. The average difference of elevation for the 21 years, 1890-1910 was 0.58-ft. less than for the 30 years, 1860-89, while for the months from April to October (inclusive) of 1911 they were 0.93-ft. nearer together than the average of the above 30-year period.

Since the water of Lakes Huron and Michigan flows through Lake Erie, any decrease of the former by excessive evaporation, deficient rainfall or diversion should reduce the level of Lake Erie in a similar amount to that by which the Michigan-Huron level is lowered, as over 95% of the water discharged from Lake Erie comes through the St. Clair River. The increase of fall in the surface of Michigan-Huron over that in Erie can be accounted for only by changes in the outlet of the former and hence it appears that channel improvements have lowered Lakes Michigan and Huron nearly 8 ins. since 1889.

It was recently a contention of the lake-carrying interests that any lowering of the lakes was a serious detriment to navigation and hence presumably to the general welfare. On this point, however, the evidence does not seem to be all one way, though if the contention be correct the navigation interests themselves are the greatest transgressors.

Considering the question first from the standpoint of navigation, an examination of the records of accidents on the waters connecting the Great Lakes for the period from 1904 to 1908 showed that 68% were attributed wholly or in part to the influence of the current. Any lowering of Lake Huron with reference to Lake Erie has the effect to decrease the slope of the connecting waters and therefore to reduce the current and so contributes to the safety of navigation. If Lake Huron were drawn down to the same level as Lake Erie there would be no more current in the St. Clair and Detroit rivers than now exists through the Straits of Mackinaw, where part of the year the flow is from Huron to Michigan, and part from Michigan to Huron.

From the standpoint of Chicago, if Lake Michigan were restored to its former elevation serious interference would result to the drainage and sewerage systems; lands now above water and at all times usable would be subject to submergence at intervals, and the safety of the works along the drainage canal might in places be questioned. On the other hand, a lowering of Lake Michigan would be met with rejoicing by every riparian owner along its borders. If its waters were lowered 4 ft. there would be made available a strip of land 100 ft. wide on the average around its entire circumference, and the value of the property so acquired would more than pay the cost of reproducing for navigation the depths of water now utilized.

So accustomed have the navigation interests become to feel that the Great Lakes were established for their special benefit that the foregoing suggestion is likely to be branded as the rankest heresy, and it may be worth while to digress and consider the grounds upon which the "paramount right" of navigation rests.

In prehistoric ages the only public use of waterways was for transportation. The water supply and the sewage disposal of the barbaric communities were problems of little moment. But the right of a man to float his canoe upon the lakes and streams was early recognized.

Congress by the Constitution was given authority to provide for the general welfare and under this clause has passed numerous laws confirming the rights of navigation; but with the modern centralization of population into great cities new problems have arisen, and while the railway and the highway have appeared as substitutes for the waterway, in many cases completely supplanting it and thus demolishing the very foundation of its paramount right, new but not less paramount uses for the waters of the Great Lakes have arisen.

The cities along their borders, either directly or indirectly, are drawing from them the water needed for domestic and manufacturing purposes and while the amount so used, even in the aggregate, is relatively small and is mostly returned to the lakes again, the principle is established that this is and must continue to be the paramount use.

A further use has been found by Chicago, in the dilution and removal of its sewage, which for many years polluted its own water supply until the death rate from water-borne diseases in this city was a disgrace to civilization. At last its citizens awoke and adopted what was then considered and is still recognized to be the most feasible method of sewage disposal. At an expense of more than $65,000,000 a great canal and waterway has been constructed along the line of the ancient outlet of Lake Michigan and since its opening hundreds of lives have annually been saved among the people of Chicago and their visitors.

Time passed and the quantity of water originally diverted became insufficient to properly perform its function of safely removing the sewage of the rapidly-growing population of Chicago, and an attempt was made to utilize the further quantity needed. Then what happened? The Lake Carriers' Association, which controls 90% of the shipping of the Great Lakes (of which 90% one company engaged solely in the transportation of iron ore controls 37%), prevailed upon the United States to refuse to Chicago permission to protect the health of its 2,000,000 inhabitants, and an injunction was issued out of a U. S. court, restraining the city from carrying out its plans, and the case is still unsettled.

Here we have Lake Michigan, owned wholly by four states (Michigan, Wisconsin, Illinois and Indiana), through whose outlet the direction of the current can hardly be determined, and an attempt made to prohibit the citizens of those states from using the water for the highest use to which water can be put, to protect the health of man. Already, as is shown by careful and extended investigation, the water flowing in the Drainage Canal is wofully insufficient to properly dispose of the sewage it carries, and the mixture is becoming a nuisance to the communities through which it flows. But the great shipping combination at whose behest the waters of Lake Michigan have been already lowered a foot, says there must be no more diversion lest the lake be lowered an inch or two and the cargoes of ore be decreased.

It is true that freight can be carried on the lakes for a much lower cost than on our railways, but of what does the lake commerce consist? In 1910, of that passing the St. Mary's Falls Canal, 34,000,000 tons was ore bound south, 9,000,000 tons was coal generally bound north, and 7,000,000 tons was miscellaneous products, including grain and flour, or less than one-third was material in which the ordinary citizen is directly interested.

The Government has provided, without expense to the carriers, their roadbed, switches and signals and while, theoretically, these are open and free to all, practically none but the favored few can afford to avail themselves of them. At what rate might we expect our railways to carry freight if they were relieved of all expense of roadbed, switches and signals.

About $6,000,000 are estimated to be spent in improvements to navigation on the Great Lakes during the next two years. And for whose benefit? The only users of the lakes requiring deeper channels are the ore-carrying vessels. The package freighters and the passenger boats all require much less water than the present channels afford, but every citizen of the United States helps pay the bills, while the citizens of the great state of Illinois are being deprived of the right to make the best possible use of a natural resource at their doors, and the neighboring states of Missouri, Kentucky, Tennessee and Arkansas are incidentally affected to their detriment.

The use of the Great Lakes for the development of power to supply light, heat and energy to the communities along their shores, is an entirely legitimate use and one that as the supply of available coal decreases, may in time become paramount, at least over navigation.

The possibility of economical power development by the present known means from the waters of the lakes, is confined to the St. Mary's River, where about 170,000 HP. (hydraulic) are available; the Niagara River, where about 7,000,000 HP. exists, and the St. Lawrence River, where about 6,500,000 HP. can be utilized. To correlate this power to something more tangible than mere figures, it may be said that the combined power of the above three rivers, if delivered at the wheel shaft of turbine wheels would amount to one-fourth as much as could be obtained with the best engines from the coal ordinarily mined in the United States if it were all used for that purpose.

Here we have a vast natural resource, one of the most valuable that nature has given to man, being absolutely wasted. The power now developed at Niagara, the "Soo" and on the St. Lawrence is only a drop in the bucket. "A mill can never grind with the water that has passed." Congress should see to it that the laws governing the use of the waters of the Great Lakes are adjusted to the requirements of the twentieth, rather than of the eighteenth century.

*Abstract of a paper presented at the National Irrigation Congress, in Chicago, Dec. 5-9.

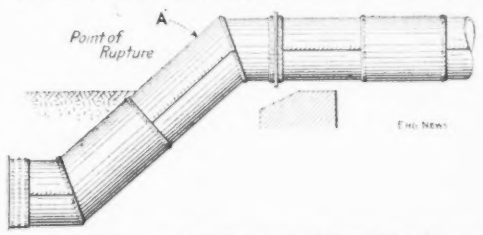
†Consulting Engineer, Ann Arbor, Mich.

The Rupture of a Wrought-Iron Water Main on a Bridge by An Automobile.

By FREDERICK I. WINSLOW.•

The accompanying sketch, from the official records of the Boston Water Department, illustrates an unusual break in a 35-in. wrought-iron pipe, where two pipes of this size take the place of a 48-in. pipe in order to cross a bridge.

An automobile traveling at an unknown speed



The Rupture of a Wrought-Iron Water Main by an Automobile, Boston Water-Works.

struck the pipe at point "A." The right forward spring penetrated the pipe sufficiently to rupture the iron for an area of about 20 sq. ins., also denting the pipe over an area of 1½ sq. ft. The accident occurred at 1 a. m., the car being a heavy Mercedes.

The pipe was laid in 1885, and did not show any signs of deterioration from casual observation of the point of rupture.

•Engineer of Extension, Water Service, Public Works Department, Boston, Mass.

Failure of Reinforced-Concrete Building Under Construction, Indianapolis, Ind.

On Dec. 6, 1911, a three-story reinforced-concrete building under construction for the Prest-O-Lite Co., at Indianapolis, Ind., collapsed without warning and carried down in the ruins some 40 or 50 men engaged upon it. Of these men eight were killed and 21 more or less seriously injured. The collapse was so complete that an ordinary inspection of the ruins does not yield much information, nor has any one officially connected with the building shown any disposition to give out any information regarding its construction and design. It will be necessary, therefore, to await an official inquiry before any very definite statement as to the causes of the failure can be made. Meanwhile, we print herewith a short account of the structure and its failure, which has been procured for us by Mr. Daniel B. Luten, of Indianapolis.

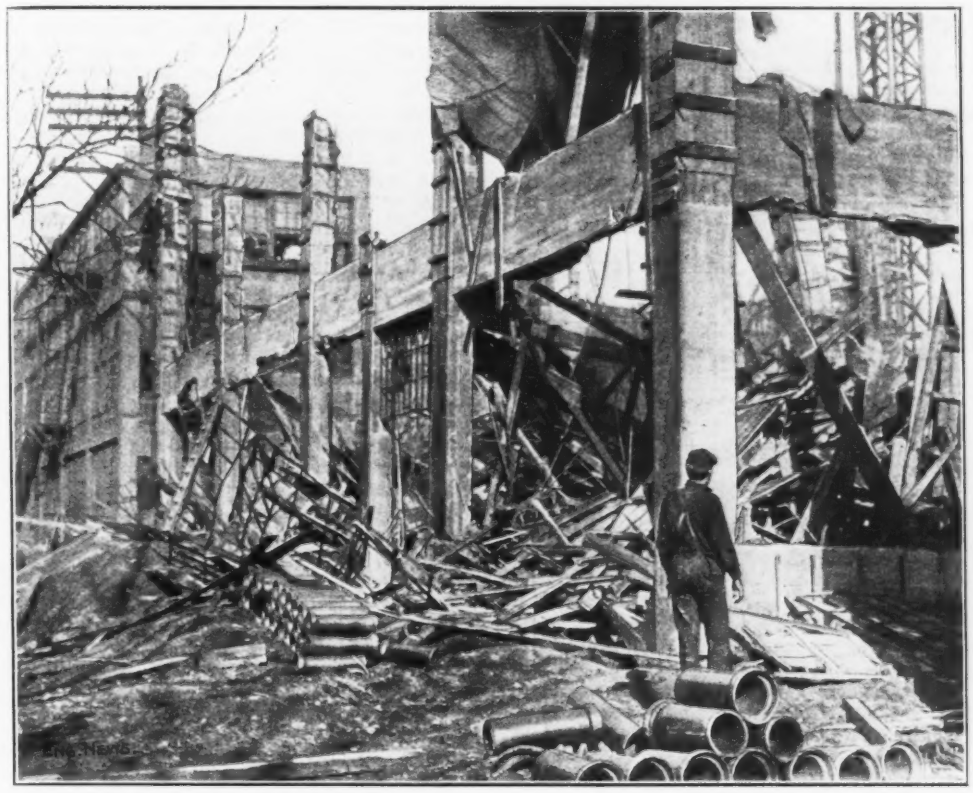


FIG. 1. VIEW OF OUTER LINE OF COLUMNS OF PREST-O-LITE BUILDING.

The building was to have been a three-story structure, 70 × 88 ft. in plan, with no basement. It was intended for use as a manufacturing plant making a specialty of automobile starters. The contract for its erection was let to Wolf & Ewing, of Indianapolis, for a two-story building designed, however, to carry a third story. Before the contractors had completed the second story it was decided to add the third story and the additonal contract was given to the same contractors. The original contract was for $12,-854, to which was added $4,500 for the additional story. While the amount of the contract was thus comparatively small, the loss of life was very great, due to the large number of men at work and the nearly completed condition of the structure.

Work was begun in September and at the time of the collapse the finishing touches were being given to the roof, the wreck thus resulting in entire loss of the structure. It is believed that the forms had been removed from the first story but that nearly all falsework supports still remained in place in the two upper stories. As nearly as can be learned at the present time failure began at an interior point above the ground floor, the confused stories related by workmen, and the leaning of the columns that remain standing, indicating collapse inward towards a central starting point.

The building was let on specifications prepared by Architect Herbert Foltz, of Indianapolis, and which provided for the submission of alternate plans. The contractors submitted plans secured from an Indianapolis engineer, representing the Olney J. Dean Co., a firm of Chicago dealers in reinforcing steel. These plans were carefully checked by the Chicago firm and approved by the architect. There is no evidence at present to show that the plans were defective. They had been approved by the building inspector of the city of Indianapolis for the two lower stories but not for the additional story, there having been neglect on the part of some one apparently in not applying to the building inspector for a permit for the third story.

The city of Indianapolis has not adopted a building ordinance for the regulation of reinforced-concrete structures. An earnest effort was made by the building inspector in 1908, aided by technical societies, to secure the passage of such an ordinance, but it was defeated in Common Council, perhaps because of lack of appreciation of its necessity. Nevertheless several reinforced-concrete buildings have been erected in the city and this is the first serious accident.

The type of construction was of columns with mushroom heads and girderless floors patterned to some extent after the Turner "Mushroom" system, but not in any way involving C. A. P. Turner, of Minneapolis, unless it be as a possible infringement of certain patents. The second floor was designed for 250 lbs. per sq. ft. and the third floor for 150 lbs. per sq. ft. There is no evidence that any excessive load was on any of the floors, except that work had been rushed in order that the contract might be completed by Jan. 1, which may have resulted in overloading the third floor supports before the columns had become strong enough to bear their load.

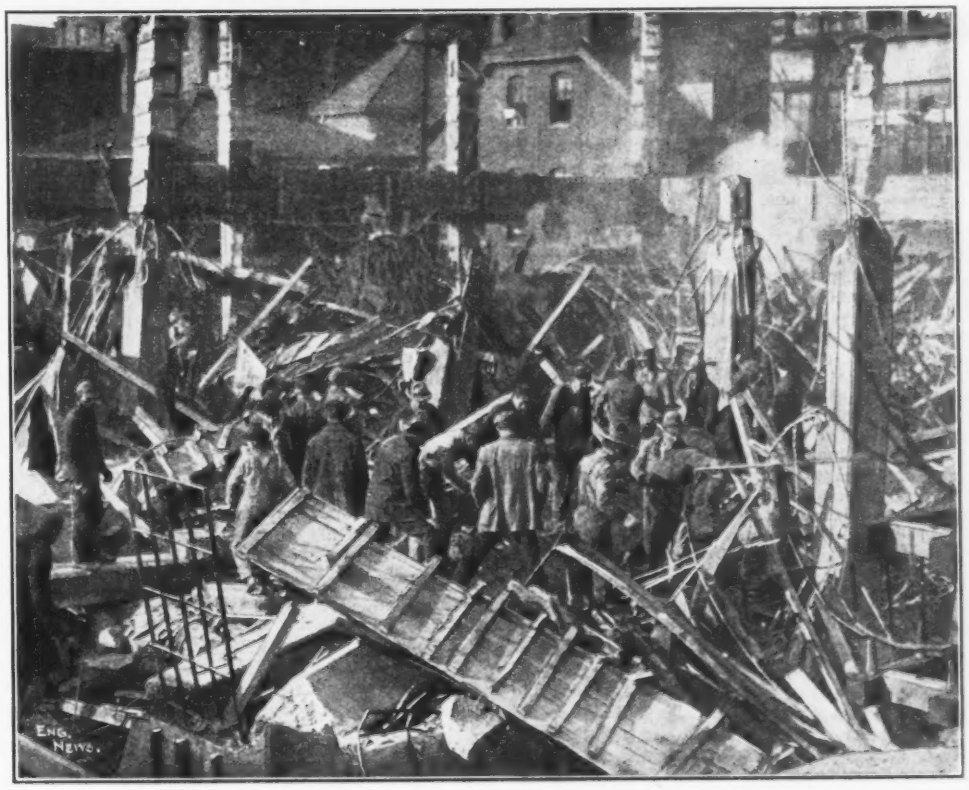


FIG. 2. INTERIOR OF COLLAPSED BUILDING.

The Relative Run-off to Sewers from bituminous-bound as compared with water-bound macadamized roads is a point worthy of consideration, according to Mr. G. Bertram Kershaw, author of a recent book on "Modern Methods of Sewage Purification." We quote as follows:

> The modern plan of tarring roads to avoid the raising of dust by traffic is a factor which will have to be reckoned with in the future. By tarring the surface of the roads they are made to all intents and purposes impermeable, and nearly the whole of a sharp shower runs off such surfaces in a very short space of time.
>
> The converse takes place with a macadam road with a dry surface; when such roads are being watered it is comparatively seldom that any liquid gets as far as the street gullies, unless the gradient is a steep one and the street surfaces very cambered.

The Purchase of the Works of the Spring Valley Water Co. is again proposed by the city of San Francisco, Mayor McCarthy having recently introduced a resolution in the Board of Supervisors declaring the intention of the Board to submit the matter of purchase to popular vote. The question was referred to the Public Utilities Committee, which was directed to notify the Spring Valley Water Co. and Mr. John R. Freeman, M. Am. Soc. C. E., of the proposition. The Committee was authorized to carry on negotiations with the company. A valuation of $25,771,986 for rate-making purposes was recently placed on the property of the company by a federal judge.

Annual Meeting of the American Society of Mechanical Engineers.

The 32d annual meeting of the American Society of Mechanical Engineers was held in New York City last week, and was characterized by an unusually large attendance and the presentation and discussion of a long list of technical papers of a high order of merit. The total number of members and guests registered in attendance was 1,250, an increase of about 200 over the registration in 1910.

The convention opened on Tuesday evening with the address delivered by the retiring President, Col. E. D. Meier, followed by a reception given by the President and President-Elect and their ladies.

Col. Meier took for his subject "The Engineer and the Future." He outlined the development of engineering from the earliest historic period in ancient Egypt and Greece and then appealed to the engineering profession to bear its part in solving the social and economic problems of the present day as follows:

Commerce, which has in large measure wrested the control of the world from the war lords, has always had as its basic principle the rule, "Buy as cheap as you can, sell as dear as you can." This has worked fairly well when cargoes of grain, wool, cotton, hemp, etc., were concerned. But where this principle was ruthlessly applied to the great producing industries of the world—where the comfort of the worker, the maintenance of his family, the very existence of his helpless children were in jeopardy—it has caused havoc, bred discontent and fomented revolution. No one who has worked among the contented, intelligent mechanics of a half century ago, can view without distress and indignation conditions as they exist to-day. Labor unionism is a protest, dangerously near a rebellion, but not a cure.

When the commanders of the industrial soldiery wrought in their midst, understood their problems, solved their perplexities, aroused and shared their enthusiasm for the quality of the product, there grew up an esprit de corps which is now sadly missing.

Without faith in the excellence of the goods produced, without enthusiasm in the work and in the leaders, productive labor becomes mere drudgery. The remedy lies in placing engineers in all the responsible positions in these great industries. Their special training fits them for leadership in this host; and leadership by him who knows, and who sinks himself in his work, always has and always will command that joyous and fervent support from his followers which money cannot buy.

The increasing multitudes of special industries are literally hungering for engineers equipped with character, knowledge and devotion, to become the expert leaders.

Labor wars will cease when such men are given the power to provide that the share in the rewards of industry shall bear just ratio to the service rendered the community. There is a sane middle ground between grasping individualism and utopian socialism.

The forces and materials we employ in our manufactures have long been and still are the subjects of most careful analysis and experimentation, to find their precise load capacity and endurance. The study of the living force and of that highest and most costly material inherent in the workman has but recently begun. But already several promising theories are undergoing exhaustive tests on a large scale. Psychological study prescribes a humane basis for them all as the condition of success.

The unrest in the modern world has its basis in an underlying sense of injustice. The growing sense of community of interest, the knowledge of our dependence on each other, the ever-expanding humanitarianism, are all founded on scientific facts, and are becoming world movements. They fervently answer Cain's question, "Thou art thy brother's keeper."

Following the address came the presentation to Col. Meier of his portrait which has been recently painted by a Boston artist to the order of a number of members of the Society who are personal friends of Col. Meier and who joined in a testimonial to him on the occasion of his 70th birthday which occurred during the Pittsburgh meeting last June. The presentation address was made by Mr. Walter McFarland.

The President-Elect, Dr. Alex. C. Humphreys, President of Stevens Institute of Technology, was then escorted to the platform and welcomed by President Meier.

The reception which occupied the remainder of the evening was held in the Society's rooms, which were tastefully decorated for the occasion, and the number present was nearly double that recorded a year ago.

General Session.

The business meeting was held Wednesday morning, Dec. 6, with Vice-President Charles Whiting Baker, in the chair. The report of the Secretary included a long list of new members admitted during the year. Some two hundred members were admitted, including associates and juniors, but the Secretary pointed out that owing

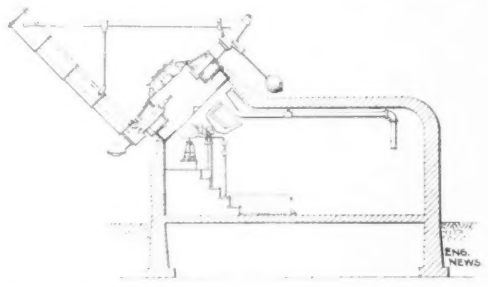


Fig. 1. Diagrammatic Section of Turret Equatorial Telescope.
(Invented and patented by James Hartness, of Springfield, Vt.)

to deaths and resignations the net increase in the Society's membership was only 108. During the year, four universities had been added to the list of those having student chapters of the Society, and the present student membership is 841.

The report of the Council, read by Secretary Rice, announced that provision had been made for local meetings of the Society to be held by the members residing in any city, at which meetings papers of local or general interest might be presented. A committee had been appointed to revise the present standards for extra heavy pipe fittings and another to prepare standard specifications for the design and construction of steam boilers.

After the reading of reports and transactions of other business, three papers were presented at this session. The first of these, by Mr. James Hartness, of Springfield, Vt., was entitled "The Turret Equatorial Telescope" and described a new type of astronomical observatory designed to protect the observer from the cold. In the common type of observatory, the telescope is installed beneath a large glazed dome. On account of the temperature effect on the expansion and contraction of different parts of the instrument the dome cannot be heated and the observer is obliged to do his work while exposed to the low temperatures frequently met at most observatories now in use. In connection with this paper it is of interest to recall that Mr. Hartness is the inventor of the turret lathe.

Mr. Hartness has designed and built a telescope which differs from previous designs intended to promote the comfort of the observer in that the polar axis of the instrument is in the form of a revolving turret. The observer is stationed in this turret. Another feature of Mr. Hartness' design is the use of a small 45° prism instead of large mirrors to turn the beam of light from the object-glass through a right angle on its way to the eye-piece. (See Fig. 1.) Figs. 1 and 2 herewith, taken from Mr. Hartness' paper, give a general idea of the telescope's construction.

A written discussion by Mr. W. R. Warner, of Cleveland, Ohio, suggested that there might be some difficulty in revolving the heavy turret by clock-work with the requisite high degree of steadiness and Mr. Ambrose Swasey, also of Cleveland, mentioned the protection of the telescope from the wind and weather afforded by the dome of the usual type. The oscillation of the telescope when exposed to a high wind might interfere seriously with the observations. Mr. Wm. Kent, of New York, approved the author's attitude in taking out a patent on his telescope and hoped it would cease to be considered improper to take out patents on scientific instruments.

The second paper, presented by the author, Sterling H. Bunnell, of New York, was entitled "Expense Burden: Its Incidence and Distribution." A method of accounting favored by the author was exemplified by accounts for a small machine shop. "Short time," according to this paper, might result from any of three causes: (1) temporary stoppage of productive units (machines) for any reason; (2) prolonged inaction of machines making goods which have only a seasonable demand; (3) bad trade conditions. Any deficit due to the first cause should be distributed to cost of work; the second, to selling expense; and losses due to the third, being neither a manufacturing or selling expense, should be regarded as a business loss to be made up by the profits of better years.

In discussing Mr. Bunnell's paper, Mr. O. M. Stimson, of Chicago, suggested that it would be of advantage to make the system of accounts harmonize with the factory system—for example, if the shop system was based on piece work, the accounting should be done on a piece-work basis. He did not believe that accurate accounting could be depended upon to assure efficient production. Accounting should detect flaws in the operating plans but should not be used as a basis for such plans.

FIG. 2. HARTNESS TURRET TELESCOPE INSTALLED NEAR THE INVENTOR'S RESIDENCE AT SPRINGFIELD, VT.

Mr. H. de B. Parsons, of New York, presented the third paper, on "Standard Cross-Sections." A sheet of standard cross-sectionings for 31 different materials supplemented this paper. These standards had been prepared by the author on the basis of replies received to a number of letters sent out by him to engineers, manufacturers, engineering societies, etc., in the United States, England, France and Germany asking that they submit their private cross-section standards. A motion was made and carried that the question of the preparation and adoption by the Society of cross-section standards be referred to the Council.

Boilers and Herringbone Gears.

Probably the most interesting paper presented t this convention was that on "Tests of Large Boilers at the Detroit Edison Co.," by D. S. Jacobus, of New York. In the absence of the author, this paper was presented at the Wednesday afternoon session by Mr. H. O. Pond, of New York. It gives the results of an unusually careful and complete series of tests on Stirling boiler units of nearly 2,500 HP., and was published in abstract in Engineering News Dec. 7, 1911, p. 680. In the tests, efficiencies ranging from about 80% to 75% were obtained with bituminous coal, with outputs of from 80% to 210% of the rated capacity. (Rating on basis of 10 sq. ft. of heating surface per boiler horsepower.)

Fifteen members participated in the discussion of this paper, a number of written discussions being submitted. Several commented on the low proportion of air to coal—about 14½ lbs. air per pound of coal—and on the fact that the efficiency was at a maximum with about 14 or 14½% of CO_2 and some CO in the flue gases. Prof. W. D. Ennis, of Brooklyn Polytechnic Institute, called attention to the fact that the various heat losses were none of them remarkably low with the exception of the radiation loss.

Mr. Wm. Kent, after remarking that the efficiency obtained was the highest ever for coal with over 25% of volatile matter, read selections from a lengthy written discussion which he submitted for publication in the "Proceedings." He stated that a curve plotted between boiler efficiency and evaporation in pounds per square foot of heating surface, using the results of the ten best tests of these boilers, followed closely the equation:

$$\text{Efficiency} = 81 - 1.33\left(\frac{\text{Evaporation}}{\text{Heating surface}} - 3\right)$$

He gave, for comparison, equations for a number of other important boiler tests. All these equations were of the same form, differing only in the constant term and in the coefficient of the term in parentheses.

Mr. R. H. Rice, of West Lynn, Mass., mentioned the advantages of large boiler units, but believed that difficulties might be met in providing adequate safety valves. He recommended the expedient of injecting large quantities of feed water when it was necessary to reduce the pressure quickly.

Mr. H. O. Pond showed a number of lantern slides showing one of the boilers at various stages of its construction.

The next paper, on "Strain Measurements of Some Steam Boilers Under Hydrostatic Pressures," was presented by the author, Mr. James E. Howard, Engineer-Physicist of the Bureau of Standards, Washington, D. C. An abstract of Mr. Howard's paper will be published in a future issue of Engineering News in connection with an article describing another series of tests of a similar nature.

A paper on "Herringbone Gears," by Percy C. Day, of Milwaukee, Wis., described the Wuest system of cutting these gears. The teeth of herringbone gears cut by the Wuest system, instead of joining at a common apex at the center of the face, as in the common type, are stepped half the pitch apart so that they do not meet at all. The object of this arrangement is to facilitate the speed and precision of the gear-cutting. Large herringbone gears are frequently cut as two-piece gears; two separate spiral gears are cut and then assembled together on one shaft as a herringbone gear. The Wuest system is intended to do away with the necessity and disadvantages of this method. Mr. Day's paper closed with an account of the various uses to which herringbone gears are especially adapted.

Cement Manufacture.

A separate session on cement manufacture was held Wednesday afternoon, simultaneously with the main session, under the control of the subcommittee on this subject. Two of the three papers presented (by J. D. Porter, of Philadelphia, and Frederick H. Lewis, of Birmingham, Ala., respectively) dealt with the use, advantages and disadvantages of electric power in cement plants. The third paper, on "The Dust Problem in Portland Cement Plants and Its Solution," by Otto Schott, of New York, will be reprinted in an early issue of Engineering News.

Foundry Session.

Three papers of interest to foundrymen were presented at the Thursday morning session, at which Mr. H. L. Gantt occupied the chair. Mr. Henry M. Lane, of Cleveland, Ohio, presented a paper on "The Core Room: Its Equipment and Management," in which he explained at length the most modern methods of core-making. The engineer's strictest requirements in the production of castings could be met, the author stated, providing that rule-of-thumb methods in the core room were replaced by more intelligent laboratory methods. The paper included a description of a modified form of cement-briquet testing machine for use in testing core materials.

A good deal of discussion was aroused by this paper, chiefly in the nature of additional information along the same line. Mr. E. H. Mumford, of Plainfield, N. J., described a jolt rammer for bench work which could be used for core ramming. It could handle cores up to 350 lbs. in weight, when operating with air at 80 lbs. pressure.

"Tests of a Sand-Blasting Machine" was the title of the next paper, presented by Wm. T. Magruder, of Columbus, Ohio. The results of the tests, which were made on cast-iron, were well summarized in the concluding sentence of the paper, as follows:

> Unless it can be shown that the extra cost of compressing 100 cu. ft. of free air per hour to a pressure of 70 or 80 lbs. per sq. in. exceeds the cost to compress it to 30 or 40 lbs. by the cost of an hour of labor (say 25 cts.), the higher pressures are to be preferred, delivered at an angle of about 45° and at a distance of about 6 ins. from the work.

In the discussion, there was some objection to this conclusion by advocates of low-pressure air for sand blasting. The strongest point advanced was that no effort was made in the tests to adjust the proportion of air to sand and that this might change the results. In closing the discussion, the author suggested that possibly any additional cost for air at the higher pressure might be more than offset by the reduced cost of machining since the scale and silicate of iron were removed by the high-pressure blast as well as the burnt sand.

A paper on "Die Castings," by Amasa Trowbridge, of Hartford, Conn., was presented by title only. It describes the methods and the principles of machines used in making small castings of finished size and shape from metals with a relatively low melting point (such as type-metal) in steel molds.

At the conclusion of this session Mr. Geo. H. Barrus, of Boston, Mass., presented a paper describing the hydraulic variable-speed transmission known as the Manly drive. Substantially the same information contained in this paper was published in Engineering News, Feb. 18, 1909, p. 182.

Gas Power Section.

A meeting of the Gas Power Section of the Society was held during the morning hour on Thursday. It opened with the annual address by the President of the Section, Prof. Robert H. Fernald, of the Bureau of Mines, at Washington. The address was devoted to a review of the progress made during the past year in gas power engineering. Much space was devoted to the development of the Diesel engine that has taken place in Europe.

The first paper on the list was by Mr. H. R. Setz, of Warren, Pa. The paper reviewed the progress being made with the Diesel engine and some of the difficulties involved in its operation. Several designs which have been brought forward by German engineers to obviate these difficulties were described, and also a design developed by the author. The last named design has been tested in a small experimental engine, but is not yet in commercial use.

Mr. Forrest M. Towl described a test of an 85-HP. oil engine made by the De La Vergne Machine Co. The engine was of the De La Vergne "F. H." type, described in Engineering News of Jan. 13, 1910. Tests showed that about 27% of the heat developed by the oil fed to the engine was converted into useful work. The highest thermal efficiency attained was 40.45%. The mechanical efficiency was 68.55%, making the net total efficiency 27.75%.

The third paper on the list was by Prof. Wm. D. Ennis, of the Brooklyn Polytechnic Institute, and discussed the mathematical principles involved in the design of small gasoline engines for automobiles.

The concluding paper of the session, by Messrs. Edwin D. Dreyfus and V. J. Hulquist, described tests on a natural gas engine of 1,000-KW. capacity, located at the Pittsburgh works of the American Locomotive Co. The engine showed a thermal efficiency measured in per cent. of brake horsepower varying from 20 to 24.45%. The natural gas used had a calorific value of 975 B. T. U. per cu. ft.

At the close of the session the new President of the Section, Mr. H. J. Freyn, of the Allis-Chalmers Co., was installed in office.

Textile Mills, Air Conditioning and Air Measurement.

At the concluding session, held on Friday morning, the first paper was one on "The Development of the Textile Industries of the United States," contributed by the sub-committee on textiles. In this paper, the present conditions in textile mills were outlined and a number of unsolved problems and difficulties were presented for the consideration of mechanical engineers. The paper stated that although automatic machinery had been developed to cut down the labor cost, the producing capacity of 100,000 sq. ft. of floor space in the mill had not been appreciably increased in the past 40 years.

The most interesting contribution to the discussion was that of Mr. Charles T. Plunkett, of Adams, Mass., who presided during the first part of this session. He stated that textile mill operatives received much lower pay in Europe than in this country (one-fourth as much in Russia, one-third in Italy, 50% in Germany and 65% in Great Britain), but that in this country the production per operative was higher. The foreign operative was comparatively incompetent and the machinery had to be run slower than was the standard practice in the United States. Hence the disappearance of native American labor was a serious problem.

Mr. Plunkett then spoke of the opportunity for improvement in the industry, mentioning one mill where a saving of 20% in the operating expense had been effected by rearranging the machinery. He referred to the loss in cotton waste as one of the most serious in the textile industry. The Germans were much in advance of other countries. In fact, he said, they utilized waste, bought from mills in Great Britain and the United States, for making a serviceable fabric. The waste shipped from German mills he described as being little more than a fertilizer.

Two papers, entitled "Rational Psychrometric Formulas," by Willis H. Carrier, and "Air Conditioning Apparatus," by W. H. Carrier and Frank L. Busey, both of Buffalo, N. Y., were presented by Mr. Carrier. The first paper dealt with the subject of artificial regulation of moisture in the air and gave a theoretical discussion of the subject, in which formulas were developed for the solution of problems. The author stated that the paper outlined a scientific solution to replace the empyric methods in common use. The second paper described various forms of air-conditioning apparatus and gave data relating to its design and operation. It also took up the subject of heat transmission in indirect surface air heaters and coolers, and developed a new theory of heat convection under forced circulation.

Prof. R. C. Carpenter, of Cornell University, commented very favorably on Mr. Carrier's papers, promising to contribute a written discussion for publication in the "Proceedings." Other written discussions by R. C. H. Heck, Frederick R. Still and J. I. Lyle were submitted for publication.

During the presentation of the last paper of

the meeting. President Meier took the chair. This paper, presented by Frank H. Kneeland, of Gary, W. Va., was entitled "Some Experiences With the Pitot Tube on High and Low Air Velocities." It describes tests made on the flow of air on an experimental pipe line erected for the study of the problem of conveying coal by means of an air blast. Three different types of Pitot tubes were used, the Taylor, Gebhardt and United States No. 1. The conclusion of the paper draws a comparison between the three types, giving the advantages and disadvantages of each.

In the discussion, Prof. Carpenter pointed out that the accuracy of the Pitot tube increased with high velocity. The chief difficulty, he said, was in getting a tube to accurately measure the static pressure. He favored for this purpose a tube of large diameter with its opening near the wall of the pipe and with baffle plates to protect it from eddies and cross currents.

The meeting was concluded with the reading by Secretary Calvin W. Rice of the report of the Research Committee, which he characterized as an "ideal monograph," by Mr. Geo. A. Orrok. The report outlined research work to be undertaken by the committee on the transmission of heat between two fluids through the walls of a tube.

Action By the Engineers' Club of Philadelphia on State Control of Dams and a State Department of Public Works.

A compromise resolution on the subject of the state control of dams in Pennsylvania was the outcome of consideration of the subject at several recent meetings, the final action being taken on Dec. 9. The resolution declares that to ensure safety, dams should be built only by engineers of ability and experience who should have constant supervision of them during construction; and the resolution requests the Governor to appoint a commission to frame legislation providing for a State Department of Public Works, to have jurisdiction over various engineering works. (The resolution in full is given below.)

Earlier action on this subject was noted in our issues of Nov. 23 and Dec. 7, 1911, the second note being in part a correction of an error made in the first one.

The Majority and Minority Reports.

The meeting on Dec. 9 was devoted exclusively to the consideration of the majority and minority reports of a committee on Government Control of the Construction of Dams in Pennsylvania. This committee was appointed on Oct. 21, 1911, just three weeks atfer the failure of the Austin Dam (Sept. 30). The committee consisted of Messrs. Edwin F. Smith, J. W. Ledoux and John C. Trautwine, Jr. On Nov. 18, a majority report, signed by Messrs. Smith and Ledoux, and a minority report, signed by Mr. Trautwine, were presented, but these were laid over for discussion at a permanent meeting to be held on Dec. 9.

Omitting the formal opening paragraphs, these reports were as follows:

Majority Report.

(1) The failure of the Bayless Pulp & Paper Co.'s dam on Freeman's Creek above Austin, Pa., on Sept. 30, 1911, calls attention to the importance of insuring the safety of such structures where failure is a serious menace to human life.

(2) Such structures should be entrusted only to engineers of ability and experience, who should have constant supervision of every phase of the construction.

Such an engineer should be not less than 30 years of age. He should be either a member of the American Society of Civil Engineers, or competent to become a member under its present rules, and he should have made a specialty of the design and construction of similar hydraulic structures. He should at all times either be personally present on the work or be represented there by a competent assistant or deputy.

(3) Therefore, your committee recommends that no such structure shall be built without a license from the state to the owner, the license to set forth the names of the engineering staff to be in charge of the design and construction. In granting this license the state reserves the right to inspect the construction of the work at any time during progress, to determine if the provisions of the license are being carried out; but, by the granting of such license and inspection, the state does not assume any liability, or guarantee the safety of the structure, and any failure on the part of the licensee to meet these provisions shall be a criminal offense against the Commonwealth, and punishable by law accordingly.

Edwin F. Smith,
J. W. Ledoux.

Minority Report.

(1) In sparsely populated and agricultural countries the individual needs but little protection from the state; but, as population becomes dense, as great corporations arise and as structures are erected whose failure means great loss of life and property, the state is forced to assert itself more and more actively, and in new directions, for the protection of its citizens. At a country cross-roads traffic may be left to regulate itself. On Broadway, freedom of action requires that the will of the individual be subordinated to the autocratic control of the policeman.

(2) We long ago recognized the necessity and propriety of governmental inspection of buildings, of boilers and of elevators; we have more lately sanctioned inspection of foods, governmental regulation of railways, etc., and now the failure of the dam at Austin, Pa., and the later failure of that at Macdonaldton, Pa., have reminded us sharply of the necessity for similar control over dams.

(3) It might be argued that self-interest should lead builders of engineering structures to take sufficient precautions; but such disasters as the two mentioned and the collapse of the Quebec Bridge show that we cannot safely rely upon the self-interest of builders to work in that direction, or leave the design and construction of such works to their uncontrolled decision, and that the state, which can earn no profit by cheapening the structure, should have final control.

(4) State or national control of dams is therefore a public necessity and in line with the inevitable trend of society.

(5) State control might be exercised by a State Engineer of Dams, by a standing or special Board of Commissioners for Dams, by some existing branch of the state government, such as the Water Supply Commission, or by a State Civil Service Commission, before whom all engineers should be required to qualify before being permitted to construct important dams.

(6) But it is unworthy of the dignity of a great state that such matters are taken up in haphazard fashion, awaiting disaster in some particular class of structures, and then awakening to the necessity of providing against that particular form of catastrophe. Such a policy leads to the creation of a heterogeneous collection of imperfectly-correlated governmental bodies, clothed with conflicting or overlapping powers and of very limited combined efficiency.

(7) The Governor of the state should therefore be requested to call together a special commission of competent engineers, from this or from other states, or both, aided by legal talent, to frame comprehensive regulations providing for the creation of a permanent State Department of Public Works, to be composed of bureaus so constituted that their combined jurisdictions should cover not only the construction of dams, but all other engineering contingencies likely to arise in the near future.

John C. Trautwine, Jr.

Discussion and Final Action on Report.

At the meeting on Dec. 9, attended by perhaps fifty or more members, nearly two hours were devoted to a discussion of the two reports. Summarized briefly, nearly all who spoke were in favor of some measure of State control of the design and construction of dams, but there was quite a difference of opinion as to how far such control should extend. Some of the speakers urged that State control should not stop with dams; in other words, they supported the minority report.

The prolongation of the debate appeared to be largely due to (1) timidity on the part of some to take a positive stand on a subject which might involve politics in the legislature; and (2) to the feeling of a few that any specific declaration of the Club, especially a declaration suggesting the desirability of a public works department, might seem to be a reflection on the present State Water Supply Commission, or might interfere with plans on foot to increase its powers and duties. Fortunately, a few speakers took a bold and strong stand to the effect that the determination of objects and methods of State control of dams or other engineering work is a subject for engineers to decide, and that lacking determination by them the features of the legislation, if any be secured, would be left to lawyers or others with utter lack of knowledge in the premises.

The final action of the Club was a compromise consisting of two paragraphs from the majority report originally numbered (1) and (2), and one from the minority report, numbered (7), the latter being slightly changed to limit the choice of commissioners on draft of an act to residents of Pennsylvania. To one who listened patiently to the rather see-sawing discussion, it appeared that the inclusion of Mr. Trautwine's paragraph (7) in the final resolution was due half to a desire for a broad measure of State control of all engineering design and construction involving possible menace to human life and half to a desire to steer clear of definite recommendations by the Club as to specific ways and means of control.

The resolution, as adopted, was as follows:

Whereas: The failure of the Bayless Pulp & Paper Co.'s dam on Freeman's Creek above Austin, Pa., on Sept. 30, 1911, calls attention to the importance of insuring the safety of such structures where failure is a serious menace to human life.

Resolved: That such structures should be entrusted only to engineers of ability and experience, who should have constant supervision of every phase of the construction. [These two paragraphs frame majority report.]

And Further Resolved: That the Governor of the state is therefore requested to call together a special commission of competent engineers, aided by legal talent, to frame comprehensive regulations providing for the creation of a permanent State Department of Public Works, to be composed of bureaus so constituted that their combined jurisdiction should cover not only the construction of dams, but all other engineering contingencies likely to arise in the near future. [From the minority report, after slight amendment; see original, already given.]

In the course of the discussion, Mr. John Birkinbine, a member of the State Water Supply Commission, stated that although his commission has no authority over dams, except in "navigable" streams, yet, since the failure of the Austin Dam public sentiment, combined with the sanction of the Governor, has seemed to warrant the inspection of dams on other streams, which has accordingly been done. In fact, the demand for such inspection has been so great as to overtax the force at the command of the Commission.

Mr. Hunter, who was State Highway Commissioner at the time of the initial failure of the Austin Dam, early in 1910, said he visited the dam shortly after the failure, and subsequently warned the borough officials that the dam was unsafe.

The National Irrigation Congress: 1911.

The 19th National Irrigation Congress was held at Chicago Dec. 5 to 9, the sessions being at the Auditorium Theater and the Orchestra Hall. The attendance was limited and some disappointment was expressed at the entire lack of interest displayed by the business interests of the city. The chief reason of selecting Chicago for the place of meeting was to bring together the irrigation interests of the West and the commercial interests of a great financial center, and it had been intended to arrange for papers and discussions relating to irrigation, finance and securities. Only one such paper was secured and there was no discussion along this line.

In smaller cities and especially in cities within the district where irrigation is a practical issue a meeting of this kind would attract general attention, but in a large city like Chicago business men and outsiders take no notice of these conventions. Consequently the parts of the hall set aside for visitors were empty, while owing partly to the many attractions of the city the delegates themselves were by no means regular in their attendance.

The proceedings consisted mainly in the presentation of papers and addresses, little time being given to discussions. In the main the proceedings were uneventful, but an important fea-

are was the organization of a Drainage Congress as an offshoot of (but in harmony with) the rrigation Congress. Two attempts were made attack the U. S. Forestry Bureau and the . S. Reclamation Service, but these attempts net with little support. At the closing session long list of resolutions was presented, and me complaint was made that these had ot been presented earlier and time given for liscussion. It was pointed out, on the other and, that resolutions continue to be submitted until near the end of the meeting, and that the ommittee on resolutions is appointed as representative of the delegates; if the latter appoint o the committee men who do not submit or enorse the resolutions desired the delegates themselves are to blame. Eventually, the resolutions were all adopted, including one over which there had been some wrangling.

At the opening session a message from President Taft was read, expressing his sympathy with the purposes of the Congress. Several of the papers on the program were not presented, and the president (Mr. B. A. Fowler, of Phoenix, Arizona) announced the disappointment of himself and the program committee at the failure of several expected speakers to make good their promises. The result was, however, that the program arrangement was followed very closely, showing that too much material had been arranged for by the committee. Even with the reduced list there was not much time to spare.

The President for 1912 is Senator F. G. Newlands, of Reno, Nevada. The next meeting will be held at Salt Lake City, Utah, in 1912.

Irrigation.

Only a part of the papers presented dealt directly with the subject of irrigation. A paper by Mr. R. P. Teele (in charge of Irrigation Statistics, U. S. Bureau of the Census) dealt with the "Magnitude of Irrigation Interests," as indicated by the census statistics. Mr. A. P. Davis, M. Am. Soc. C. E. (Chief Engineer of the U. S. Reclamation Service), gave a paper on "Irrigation in Turkestan," reprinted on p. 722. In a paper on "Government Irrigation in Montana," Senator Whiteside complained of certain features in the administration of the reclamation law in his state, claiming that the work was done too slowly and at excessive cost. "The Present and Future of Irrigation Development" was the subject of a paper by Mr. Samuel Fortier (U. S. Dept. of Agriculture); he explained that the Office of Irrigation Investigations, under his department, receives annual appropriations from Congress and covers the arid and semi-arid belts, besides studying the question of supplemental irrigation in the humid region. The census for 1910 gives the amount of money invested in irrigation works as $308,000,000, which he considered small in relation to the values created by the water thus furnished. The area of land this developed by various clases of enterprise are as follows, and it was explained that the "irrigation districts" are a sort of municipal corporation:

	Acres.	Per ct. of total.
Individual and partnership....	6,258,00	45.5
Cooperative	4,646,000	33.8
Commercial	1,445,000	10.6
Irrigation districts	533,000	3.9
U. S. Reclam. Service.....	396,000	2.9
Carey Act enterprises*.....	289,000	2.1
U. S. Indian Service.....	173.000	1.2
Total.....	$13,710,000	100.0

*Under this act the National Government grants to each of the arid states not exceeding a million acres of desert land, with the proviso that the state shall obligate itself to reclaim the same and cause it to be occupied by actual settlers in small tracts. The states which accept the act in turn enter into contracts with corporations which construct the works and sell water rights to the settler.

As to the future, Mr. Fortier considered that the development has so far progressed beyond the demands for settlement, so that it may be well to slacken the too-rapid rate of progress. In close relation with his paper was one on "Irrigation in the Humid States," by Mr. Milo B. Williams (Irrigation Engineer, U. S. Dept. of Agriculture). The subject of "Irrigation Finance" was dealt with in a paper by Mr. Norman E. Webster (New York), but this was passed without discussion, although the subject is one of great importance in relation to the development and promotion of irrigation projects. Two papers were read on irrigation methods in Australia, where the work is undertaken by the government.

In one of the resolutions adopted, the Congress advocated state supervision of all irrigation projects and means to check "wildcat" schemes. Such supervision was denounced by one or two speakers, who declared that while they believed some check should be put on these schemes, state supervision was not the proper means of control, and that this resolution should at least be referred to the next Congress. In reply, Mr. Geo. H. Maxwell (Pittsburgh, Pa.) declared that he thought the Australian system of government ownership and control would be adopted eventually in this country, but that pending such a radical change (for which we are not yet ready) he advocated control by each state of the projects within that state. As far as "wildcat" schemes are concerned he expressed the opinion that an era of such schemes for the booming of land investments is now impending and needs to be held in check for the protection of the public. After a short but rather acrimonious debate the resolution was adopted.

Drainage.

The subject of the reclamation of swamp and overflowed lands by drainage has been given increasing attention by the Irrigation Congress, and at its meeting at Pueblo, Colo., in 1910, it adopted a resolution in favor of such reclamation. In view of this policy, the subject of drainage had been given good representation on the program, and the opinion had been expressed that the Congress should include drainage as an auxiliary part of its work. When this matter came up for consideration on the floor, however, considerable objection to this was made evident, principally on the part of delegates from Western states who feared that irrigation would not receive a proper share of attention if the purposes of the Congress were thus divided. As a result of this opposition, the organization of a National Drainage Congress was decided upon, independent of but auxiliary to and in close harmony with the National Irrigation Congress. The Drainage Congress was organized therefore, with Mr. Edmund T. Perkins (Chicago) as President, and it was stated that it would hold a meeting at New Orleans in February.

Mr. W. L. Park (1st Vice-Pres., Ill. Central R. R.) read a paper on "Drainage as a Basis for Development," in which he advocated the undertaking of such work by the national government in the same way as it has undertaken the work of irrigation. Mr. A. R. Lawton (Vice-Pres., Central Georgia Ry.) also dealt with the subject of "Drainage to Develop Commerce and Industry." The "State Aspect of Drainage" was dealt with by Judge R. V. Fletcher (Illinois), and "Reclamation a National Duty" was the title of a paper by Mr. Hunter C. Leake (New Orleans), in which the conditions of the lower Mississippi Valley were dealt with particularly. He estimated that there are 70,000,000 acres of land in the United States which can be reclaimed by drainage. The idea of having such work undertaken by the Federal government appeared to receive general approval, but in view of the objection to having the Congress divide its attention between irrigation and drainage, led to the formation of a separate organization in order to avoid the threatened opposition, as above noted.

While a popular and illustrated talk on irrigation ("Making the Desert Blossom") was given one evening by Mr. C. J. Blanchard (Statistician of the U. S. Reclamation Service), the opposite subject received equal attention. This second illustrated lecture was on "The National Aspect of Swamp Drainage," by Mr. M. O. Leighton (Chief of the Hydrographic Branch, U. S. Geological Survey). Some extracts from this we shall give later.

Other Subjects.

In a paper on "The Uses of the Great Lakes," Mr. Gardner S. Williams, M. Am. Soc. C. E. (Ann Arbor, Mich.), reviewed their use for navigation, sanitation and power purposes, relegating the first of these to a very minor portion in view of the public interests in the other two, and of the fact that the very deep channels are needed only by special private interests engaged in carrying ore. For the ordinary package freight and passenger service, the existing channels give ample accommodations. Of a different character were addresses on "Stream Pollution," by Dr. W. A. Evans (Chicago), and on "Water-Supply in Relation to Food Supply," by Dr. H. W. Wiley (Chief of the Bureau of Chemistry, U. S. Dept. of Agriculture).

Mr. Geo. H. Maxwell (Pittsburgh Flood Commission) discussed the subject of the regulation of flow in rivers as related to the four features of irrigation, drainage, navigation and forestry. His special object was to urge the policy of establishing head-water reservoirs to regulate the flow, prevent floods, and give a supply of water when needed. His purpose was to secure the support and endorsement of Senate Bill No. 10,900 introduced at the present session of Congress by Senator Newlands (Nevada); this provides for the creation of a Board of River Regulation, with an appropriation of $50,000,000 annually, and for the supervision of all work by the Corps of Engineers, U. S. Army.

An address on the conservation movement was given by Mr. Gifford Pinchot, and an attack on this movement as well as upon the U. S. Forest Service was made by Mr. Bartlett (Wyoming). Objection was made to including Mr. Bartlett's speech in the published proceedings, but after some discussion it was voted to refer the matter to the executive committee. A paper by Judge George H. Hutton (California) dealt with "The California Doctrine of Appropriation and Riparian Rights." Several addresses, dealing largely with land development, were made by delegates from individual states, and by the representatives of foreign nations (which included Canada, Australia, Germany, Russia and some of the South American states).

The Market Value of Knowledge.—For some months past the discussion columns of contemporary journals devoted to civil engineering have contained letters complaining of the low salaries paid to surveyors and civil engineers engaged in similar lines of work. In the comment made upon the situation two important points seem to have been overlooked.

One of these is that the average graduate of a technical school is, immediately upon graduation, incapable of performing most of the duties of engineering work without a preliminary period of training. Surveying is one thing which he can do satisfactorily, providing he has received his college training at one of a large number of efficient schools. As a result the post of surveyor is the accepted starting point of the young engineer in the larger number of cases. The supply is therefore ample, the demand limited; the result follows naturally.

The second point is that the mere possession of knowledge has little earning capacity, only skill in the application of knowledge to the attainment of some useful purpose has earning power, because it is from such application that useful results flow.

To put it briefly the manager draws the large salary because he makes or mars the profits of the enterprise. The horses furnish the strength and speed to haul a dray and receive their board and keep; the man who hitches them in their proper position and guides their efforts in the proper direction receives a wage. Complaint is often made that there are few technical men at the head of large enterprises, but nothing is more certain than that if technical men as a class exhibited notable ability in the management of large enterprises their services would be in urgent demand. The head of a large enterprise becomes perforce a clearing-house of knowledge, rather than a treasury of information; the demands made upon him are so various that he must of necessity rely upon others as sources of information. On any subject there are available scores of men competent to collect data; the man who can see straight through the mass to the essential fact and set it in its right relations is the man who produces results and is rewarded accordingly.—"Mining and Scientific Press."

Irrigation in Turkestan.*

By ARTHUR P. DAVIS,† M. Am. Soc. C. E.

Western Turkestan is a portion of the Russian empire and comprises the southwestern part of Asiatic Russia. Within its limits are the provinces of Sir Daria, Farghana, Samarkand and Trans Caspia. These have a total area of 1,680,000 sq. mi., and a population of about 9,000,000. The same general area also includes the provinces of Khiva and Bokhara, which are nominally independent principalities, but are under the protection of Russia.

Nearly all of the drainage of Turkestan is into the Aral Sea, a body of water about 200 miles long and 150 miles wide. It is only about 60 ft. above sea level. The eastern and southern portions of Turkestan are traversed by lofty mountain ranges, upon which the precipitation is very great, and is mostly in the form of snow. These mountains are drained by numerous streams, most of which lose their waters in the great sandy deserts of Central Turkestan, but the largest two of which reach the Aral Sea.

Most of the streams are used more or less for irrigation, the total irrigated areas in Turkestan being nearly 6,000,000 acres, of which over 33% is in Farghana, and 50% in Samarkand and Sir Daria. Agricultural and pastoral pursuits are the chief occupations, and the state of civilization is similar to that of Mexico and Central America. Plowing is done with a forked stick shod with iron, drawn by oxen or horses. Camels are extensively used as beasts of burden, and the donkey is also much in evidence.

The climate is very cold in winter and hot in summer. The precipitation in the valley regions is from 5 to 16 ins. per annum, but in the lofty mountains is very great, and is mostly in the form of snow.

The largest river is the Amou Daria or Oxus, which rises in the high mountains of the Hindu-Kush and Kuen Lun. It is nearly 2,000 miles in length, 800 miles of which are the valley portions of the main stream to the Aral Sea. Innumerable small diversions for irrigation are made from this stream and its tributaries in the rude way characteristic of primitive peoples. There is still a very large unappropriated flow of water, but the small declivity of the river and the undesirable character of the land outside of its immediate valley have so far not attracted the investment of capital.

The valley of the Amou Daria for a width of over 60 miles is occupied mainly by sand dunes almost bare of vegetation and constantly shifting under the action of the wind which prevails from April to September, inclusive. In the winter months it blows more from other directions. It is said that 12 years ago trains passing through this region averaged less than 2 m.p.h. on account of sand obstruction, and had to carry a crew of laborers to shovel sand off the track. During the past 12 years, efforts have been made to cover a zone along the track with vegetation to break the force of the wind and hold the sand in place. An experiment station was established at Farob, and in 1898 the propagation of native plants was begun. Seeds of the native desert shrubbery were planted in a nursery, where the sand was covered with brush and staked down to keep it from blowing away. The young shrubs were transplanted from the nursery to a zone 1,000 ft. wide on the west side of the railway and 500 ft. on the east side. About 15 to 20% of the plants grew and spread by natural seeding. The vegetated area is now more than 1,000 ft. wide on each side of the track for a part of the distance, and great benefit has resulted. The work is still in progress.

The most important and best constructed irrigation system in Turkestan is on the estate of the Czar, on the Murgab River, with headquarters at Byram Ali. The first recorded irrigation construction in the Murgab Valley was in the 12th century, a dam being built about 60 miles above Byram Ali and irrigating over 50,000 acres. The location was at the very head of the valley, where the sand dunes begin to encroach upon the river. This ancient canal system was destroyed by Ghengis Khan, and the valley was consequently depopulated. It was rebuilt by a grandson of Tamerlane in the 15th century. In 1799 the system as rebuilt was destroyed by the Emir of Bokhara, and the valley was again depopulated and reverted to desert.

After the conquest of Turkestan by Russia, the valley was added to the emperor's estate and in 1887-89 the dam at Sultan Bend was rebuilt for the emperor by the engineer Kosel-Poklevsky, a Polish revolutionist, who had been banished to Siberia, served his term and came to Byram Ali. He made brick and hydraulic lime on the ground, of which he built the dam, upon a foundation of loess, which was recognized as unsuitable for a high dam.

To guard against accident, he built three dams so situated as each to stand one-third of the head. The lower two had no gates; the upper one had gates. All these dams were built in the dry, at one side of the river. After their completion, a dam was built in the river channel of fascines, earth and rock, and the water accumulated behind during the low-water season. As it was closed, the bank was cut above the three dams to allow the water to pass through the gates therein provided, but instead of doing so it cut a new channel, leaving the dams high and dry.

In 1895, an engineer named Andreyeff was employed to build a dam at Hindu-Kush, where a power plant is located which uses for power the water that runs down the river to Merv, to satisfy prior rights. This power is transmitted to Byram Ali, and used for lighting and running the cotton machinery. The capacity of this reservoir is 10,000 acre-ft. There are three valley reservoirs with a combined capacity of 23,000 acre-ft. The canal system from the Hindu-Kush reservoir was built by Von Valueff. The main canal is 17 miles in length and is called the Tzar Canal. It has a capacity of 500 cu. ft. per sec. and irrigates 5,000 acres of cotton and 7,000 acres of wheat and barley. In April and May, 1903, came great floods which filled the reservoir with sediment.

In 1910, Von Calueff built the Sultan Bend and Yolatan reservoirs, each of 55,000 acre-ft. capacity. The latter backs water to Sultan Bend, which is located at the head of the valley near the site of the original dam built in the 12th century. Most of the structures are built of brick and are very heavy and substantial.

The total storage capacity on the estate is about 140,000 acre-ft., but this will rapidly decrease with accretion of sediment. The total diversion capacity of the system is about 1,500 cu. ft. per sec., and serves about 60,000 acres. Cotton, wheat, barley, alfalfa and fruit are the chief products.

The next largest stream in Turkestan is the Sir Daria which is, in general, about half the size of the Amou Daria and has a minimum flow of more than 15,000 cu. ft. per sec. These two are the only streams in Turkestan which reach the Aral Sea, the rest being lost in the desert or consumed in irrigation. A large number of small canals have been diverted from the Sir Daria in Farghana, Samarkand and Sir Daria provinces. These are used for irrigating temperate-zone crops, including grains and forage plants, some fruit trees, and a large amount of cotton.

A large canal taking water from this river was built as a private enterprise by the Emperor Nicholas I. Taking advantage of a series of islands, it diverted about 300 cu. ft. of water per sec. into a canal with a length of about 28 miles on the river bottom lands, and an equal distance over the desert on the bench to the west of the river, all in the province of Samarkand. This system, however, was built on too flat a grade. Its diversion point is unfavorable and unreliable, and the entire canal is located on low ground in such way that it is difficult to carry the water to the fields to be irrigated. The ill success of this system has led to an enterprise on the part of the Russian government to supersede the existing canal system by means of another heading further up the river and built on a heavier grade, which will command the same lands and a little more. This canal is now under construction and the main canals of the old system will be, in the final plans, used for drainage.

It appears to be feasible to divert the Sir Daria into a very large canal near the town of Khojend on the left bank and carry the same in a course practically westward to irrigate the vast plain known as the Golodnaya Steppe, where nearly a million acres of very fine land can be found; this district is smooth, has an excellent soil, and a slope favorable for irrigation. It is probable that the water supply is not sufficient to irrigate this entire tract, but this must depend upon complete adjudication of prior claims to the waters of the Sir Daria.

*Abstract of a paper read at the National Irrigation Congress, Chicago, Dec. 5.

†Chief Engineer, U. S. Reclamation Service, Washington, D. C.

The Commission Plan of City Government and municipal ownership of water-works were carried at an election in Centralia, Wash., on Nov. 20. It is stated that a corporation seeking a 50-year water franchise tried hard to down both propositions. The vote on the commission plan was 858 for to 377 against.

The Report of the New York Inspector of Dams and Docks on the Austin Dam Failure.

Shortly after the failure of the Austin Dam the New York Conservation Commission appointed Mr. Alex. Rice McKim, M. Am. Soc. C. E. Inspector of Dams and Docks for the Commission. Mr. McKim visited the Austin Dam, twelve days after its failure and prepared a brief report upon it, extracts of which have appeared in various newspapers. Mr. McKim's full report was made public on Dec. 8, and we reprint it as follows:

On October 11 last I inspected the remains of the dam at Austin, Pa., owned by the Bayless Pulp & Paper Co., at Binghamton, N. Y. The Commission might well have sent me to examine this dam and site in order to impress me with the responsibilites of my office, for the washing out of the dam has left ruin and desolation in its track, and shows most emphatically the need of State Supervision for all such works in the interest of the surrounding community.

This dam was built of concrete in which large stones were embedded. It was 40 ft. high, 544 ft. long, 2½ ft. wide on top, and supposed to be 30 ft. wide at the base. It was completed Dec. 1, 1909, and filled Jan. 21, 1910. Two days later a section slid out some 18 ins. at the base, and water in large quantities came through the ground below the dam. The reservoir was then emptied, a short section at the top 2 ft. deep having been blown out by dynamite in an attempt to hasten its discharge. A month afterward, without any strengthening whatsoever, the dam was refilled up to the breach made by the dynamite. At this time there was a leakage under the dam of 600 gals. per min. On Sept. 30 last the dam gave way completely.

The failure was principally due to the dam not being properly bonded to the foundation rock bed beneath, and so it slid forward under the pressure of the water impounded, aided by water leakage under the dam.

The engineer's plans, as published, show the concrete of the dam running down into a channel cut from the rock foundation bed, 4 ft. deep and 4 ft. wide, for the entire length of the dam. But on the up-turned section of the dam now lying in the river, I could see no evidence of any such wall having been built into the rock at all. As far as I could see from this section, and from the east remaining section, which has moved but little, the dam was simply placed on top of the rock bed and not let into it anywhere.

The only anchor was 1¼-in. rods every 2 ft. 9 ins. along the upstream face. And these were absolutely of no use, because when they had been stretched so as to act, the whole dam was in motion, when nothing could have stopped it. Dams should be built heavy enough to resist all possible opposing forces without depending upon steel reinforcements which cannot be brought into action until the masonry has failed.

Other defects were as follows: The seams in the rock bed above the dam were not all cleaned out and grouted, thus leaving easy access to water under the dam. The dam was built much too light, that is not thick enough; the top thickness was but 2½ ft. and it should have been at least 4 ft. and 5 ft. would have been better, and the bottom width, shown on the published plans as 30 ft. measures on the east remaining section mentioned above only 20 ft.* The spillway was rather small, being but 4 ft. by 50 ft. for a drainage area of 25 square miles. Many of the rocks imbedded in the concrete in the dam were of soft sandstone, slate, talc and other laminated rocks easily sheared in one direction, and laid so as to offer little resistance to horizontal shearing; one large section was broken off, splitting the rocks.

A Road Materials Testing Laboratory is to be provided for the recently-established Road Board of Great Britain. It will be located at the National Physical Laboratory at Teddington, where various tests of road-making materials will be made. Arrangements have also been made with the British Geological Survey to receive and store samples of stones thought suitable for road purposes and to prepare a report on thin slides of the samples; in other words to carry on petrological work.

*[The width of the dam at its base depends, of course, on its height. As the valley of the stream was much higher at the sides than in the channel, the height of the dam above the ground level was much less at the ends and the width of the base was correspondingly reduced.—Ed.]

A Powder-Mill Explosion at the fireworks factory of E. S. Hunt & Co., at Weymouth, Mass., Dec. 5, wrecked the mixing building, a wooden structure, 50 × 75 ft., with a property loss estimated at $2,000.

A Railway Bridge Under Construction Collapsed Dec. 8, falling into the River Volga, near Kazan, Russia. Reports state that 150 workmen were carried down with the bridge. The accident is ascribed to the pressure of an ice pack which formed in the river above the bridge.

A Series of Rear Collisions wrecked two freight trains and one express train on the Pennsylvania R. R., near Manor, Pa., Dec. 6. Two trainmen and four men in charge of horses on the express train were killed. The accident occurred during a fog. An extra westbound freight train was forced to come to a stop and was struck almost at once by a second extra freight which closely followed it. The wreckage of these two trains was struck by an express train, also westbound.

A Coal-Mine Explosion at Briceville, Tenn., in the Cross Mountain mine of the Tennessee Coal Co., Dec. 9, entombed about 100 miners. The explosion occurred soon after the day shift had entered the mine in the morning. On Dec. 10, the bodies of eight men killed by black damp were taken out by rescuers. On Dec. 11, the rescue car of the U. S. Bureau of Mines arrived at Briceville and five men were rescued alive from the mine. They had protected themselves from the suffocating gases produced by the explosion by barricading themselves in a cross entry. On the night of Dec. 12, a total of 35 bodies had been taken from the mine in addition to the five men rescued alive. No accurate figure is available for the number of men in the mine at the time of the explosion.

An Outside Explosion Blew Up the "Maine" according to the recently presented report of the Board of Army and Navy officers appointed (Eng. News, Nov. 16, 1911, p. 610) to study the now exposed wreck. The entire report of the Board has not been made public, but Secretary of the Navy Meyer has issued the following statement:

The Board finds that the injuries to the bottom of the "Maine" were caused by the explosion of a charge of a low form of explosive exterior to the ship between frames 28 and 31, strake B, port side.

This resulted in igniting and exploding the contents of the 6-in. reserve magazine, A-14-M, said contents including a large quantity of black powder.

The more or less complete explosion of the contents of the remaining forward magazine followed. The magazine explosion resulted in the destruction of the vessel.

This report accords in general with the one made by the Sampson Board in March, 1898, immediately after the explosion.

Irrigation Statistics of California.—The total area irrigated in 1909 was 2,664,104 acres, an increase of 1,217,990 acres, or 84.2%, over that of 1899. The area included in projects either completed or under construction in 1910 was 5,490,360 acres. The total length of all ditches was 21,129 miles, of which 12,599 miles were in main canals and 8,530 miles in laterals, an increase of 146.7% in 10 years. There were in 1909, 1,604 reservoirs with a combined capacity of 743,269 acre-ft., 10,710 wells, and 9,267 pumping plants with a total engine capacity of 123,590 HP. Less than 1% of the total area was irrigated by the United States Reclamation Service and the United States Indian Service. Irrigation districts supplied water for 6.5% of the total acreage; cooperative enterprises 29.2%; commercial enterprises 28%; individual and partnership enterprises 36.1%. The total cost of all the irrigation systems in 1910 was $72,445,669, an increase of 277.7% in 10 years. The average cost per acre was $20.02 in 1910, against $13.26 in 1899. The average cost of operation and maintenance per acre in 1909 was $1.54.

Another Typhoid Fever Outbreak at Trenton, N. J., apparently due to the sewage-polluted Delaware River water supply, is reported. From Nov. 1 to Dec. 9, 1911, there were reported to the State Board of Health 89 cases of the disease, according to information supplied to us by Dr. Bruce S. Keator, Secretary of the Board. The following statements are from a circular issued to the citizens of Trenton by the State Board of Health on Dec. 5, 1911:

Just preceding this prevalence of typhoid in Trenton, the same disease has prevailed in epidemic form in several communities that are located north of Trenton on tributaries of the Delaware River. It is probable, therefore, that the present outbreak of typhoid in Trenton is due to the water supply.

Fortunately there is already at hand a means of rendering the water supply safe for drinking. A plant for the disinfection of the river water by the application of calcium hypochlorite has been in operation experimentally for the past few weeks. Application of hypochlorite to the Trenton water began on Nov. 9. The amount of hypochlorite being added was found to be too small to accomplish sterilization. This amount has very recently been increased and satisfactory results are now being obtained.

At this critical moment we believe it to be necessary to add larger amounts of hypochlorite to the water than have hitherto been used in order to bring about effective sterilization and thus be certain of killing off the typhoid organisms. This step may possibly result in the production of tastes and odors in the water. These tastes and odors are, however, harmless to the person drinking the water. Obviously, the discomfort of this slight taste and odor, which will be only temporary, is preferable to the presence of typhoid germs in the water.

As soon as a noticeable abatement in the epidemic is effected, and further experimentation shows what amount of hypochlorite it is necessary to add to accomplish satisfactory sterilization, the proportion of hypochlorite may be reduced.

The Filling of Gatun Lake, Panama Canal, will cause the abandonment in February, 1912, of the present line of the Panama R. R. between Gatun and Gorgona. The removal of inhabitants of villages in this section is now being hastened. Villages and settlements which will be inundated by Gatun Lake when the level has reached 85 ft. above mean tide are: Lion Hill, Ahorca Lagarto, Bohio, Penas Blancas, Frijoles, Tabernilla, San Pablo, West San Pablo, Bailamonos, Mamei, Juan Grande, Gorgona (partly), Matachin, Bas Obispo (partly), Auguas Claras, Guarapo, Montevistoso, Monte Lirio, and Limon. A new village of Monte Lirio is being built on the relocated Panama Railroad. Other new villages on it at present are New Frijoles and Gamboa. Half a dozen of the present villages will be abandoned from causes other than flooding. They are Miraflores and Pedro Miguel, on account of construction connected with locks, and Mandingo Llano, Rio Grande, Cucaracha, New Culebra and Spanishtown, the existence of which is not regarded as worth the cost of their sanitary maintenance.—"Canal Record."

Panama Canal Excavation during November totaled 2,598,024 cu. yds., a daily average of 108,251 cu. yds. for the 24 working days in the month. During November 107,672 cu. yds. of concrete was laid and 523,520 cu. yds. of fill placed in dams. The rainfall for the month was 11.92 ins.

The Chicago Gas-Rate Ordinance, limiting the price of gas in that city to 75 cts. per thousand feet until July, 1912, to 70 cts. for the next two years and to 68 cts. for two years after that, has been upheld by Judge Kickam Scanlon in the State Superior Court. A temporary injunction has been issued restraining the Peoples Gas Light & Coke Co., from violating the ordinance. However, the company will be allowed to collect 80 cts. per thousand until the suit is finally decided, the difference being deposited with a trustee.

The Deferred-Message Cable Rates, recently announced by the Western Union Telegraph Co., (Eng. News, Sept. 21, 1911, p. 354) have now been published. The new schedule provides for "cable letters," subject to a two-day delay in transmission, at 7½ cts. per word between Boston or New York and Liverpool or London. "Week-end letters," subject to a delay of from Saturday to Tuesday, will be sent for 5 cts. a word. There is also an undefined "deferred press dispatch" at 5 cts. per word. These rates include mailing or such delivery as the cable company desires. The messages will be forwarded to any destination at the regular, "day-letter," or "night-letter" rates prevailing for land lines. Messages must not be in code.

A Committee on Rubber Analysis was appointed at a conference held on Dec. 7 in New York City by representatives of the U. S. Army, the New York Central R. R., Pennsylvania R. R., General Electric Co., Standard Underground Cable Co., Simplex Electrical Co., Hazard Manufacturing Co., the American Chemical Society and several independent chemists who have made a specialty of rubber analysis. The conference was called by Mr. E. B. Katte, Chief Engineer of Electric Traction, New York Central & Hudson River R. R. The committee was instructed to determine a standard procedure in the analysis of rubber compounds, the idea being to establish a definite basis for the insertion of chemical-analysis clauses in specifications for rubber insulating compounds. Members of the committee are as follows:

Mr. H. B. Rodman, Chemist, Pennsylvania R. R., Altoona, Pa.; Mr. C. R. Boggs, Chemist, Simplex Electrical Co., Cambridge, Mass.; Mr. W. B. Gieser, Chemist, New York Central R. R., Albany, N. Y.; Mr. P. Poetschke, Chemist, The Lederle Laboratories, 39 West 38th St., New York City; Mr. James P. Millwood, Consulting Chemist, 246 Willoughby Ave., Brooklyn, N. Y.; Mr. Wallace Clark, Head of the Wire & Cable Dept. of the General Electric Co., Schenectady, N. Y., and Mr. W. A. Del Mar, Asst. Engr., New York Central R. R., New York City.

Suggestions and communications will be received by the Secretary, Mr. W. A. Del Mar, 335 Madison Ave., New York City.

Intercepting Sewers to lead the sewage from north shore towns to the North Channel of the Chicago Drainage Canal will be built by the Sanitary District of Chicago when these towns provide for sewer systems in connection with the interceptors. This action has been decided upon by the Sanitary District in view of the fact these towns cannot afford to build the works necessary to deliver their sewage to the new channel. It is expected that similar action will have to be taken for the relief of that part of Chicago south of 87th St., in order to connect that section with the new Calumet Channel now under construction. The north shore towns in question will be requested to submit plans of their proposed sewerage systems, showing how these may be reached by the interceptors.

Personals.

Mr. Paul Schultze, M. Am. Soc. C. E., County Superintendent of Highways, Oneida Co., New York, has been chosen City Engineer of Troy, N.Y.

Mr. O. K. Morgan, formerly Chief Draftsman of the Carolina, Clinchfield & Ohio Ry., has been promoted to Chief Engineer of the same. His headquarters will be at Johnson City, Tenn.

Mr. W. T. Thompson, formerly General Manager of the Iroquois Iron Works, Buffalo, N. Y., has been elected Vice-President and General Manager of the Monarch Road Roller Co., of Groton, N. Y.

Mr. M. C. M. Hatch, formerly Chief Draftsman of the Boston & Maine R. R., at Boston, Mass., has been appointed Engineer of Tests of the New York, New Haven & Hartford and Boston & Maine R. R. Cos., at Boston.

Mr. H. C. Landon, formerly Division Engineer of the Erie R. R., has been appointed General Manager and Chief Engineer of the Watanga R. R., a new line to be built from North Carolina to Eastern Tennessee. His headquarters will be at Lenor, N. C.

Mr. Jean Bart Balcomb, Consulting Engineer, of Chicago, Ill., has been appointed Executive Engineer of the Alvord Valley Irrigation Co., which has under way the development of a tract of land in southeastern Oregon. He will retain his office in Chicago, Ill.

Mr. Samuel G. McMeen, M. Am. Inst. E. E., Consulting Engineer, of Chicago, Ill., has been elected President of the Mount Hood Railway & Power Co., of Portland, Ore. His work in Portland will not necessitate severing his connection with the firm of McMeen & Miller, of Chicago.

Gen. Hugh Bancroft, of Boston, Mass., has been appointed Chairman of the new harbor commission of Boston, known as the Board of Directors of the Port of Boston. Other members of the commission are Hon. J. A. Conry, Rear-Admiral Francis T. Bowles, Messrs. W. F. Fitzgerald and Geo. E. Smith.

Mr. I. A. Cottingham, Engineer of Maintenance-of-Way of the Houston & Texas Central, the Houston, East & West Texas and the Houston & Shreveport Rys., has been promoted to Assistant General Manager of the same, with jurisdiction over the same department and such new duties as shall be assigned to him.

Mr. D. K. Colburn, Engineer of Maintenance-of Way of the Galveston, Harrisburg & San Antonio and the Texas & New Orleans Rys., has been promoted to Assistant General Manager of the same lines. He will continue to have charge of his present department and will assume such other duties as shall from time to time be assigned.

Mr. Francis V. Marshall, formerly Assistant Engineer of the Wabash R. R., at Decatur, Ill., has been promoted to Engineer of Maintenance-of-Way of the Springfield and Decatur divisions of the same railway, succeeding Mr. Edward Shelah, who has retired owing to ill health. Mr. Shelah

will be retained by the railway as Consulting Engineer.

Mr. C. A. Hamilton, M. Am. Soc. M. E., for the past six years Vice-President and General Manager of the Wisconsin Engine Co., Corliss, Wis., has resigned to become Vice-President and General Manager of the Lavigne Gear Co., of Milwaukee, Wis., a new corporation organized for the purpose of manufacturing automobile steering gears and accessories.

Mr. William E. Swift, M. Am. Soc. C. E., until recently Division Engineer, Hudson River Division, Board of Water Supply of the City of New York, at Cornwall-on-Hudson, N. Y., has become associated with the firm of Ford, Bacon & Davis, Consulting Engineers, 115 Broadway, New York City. Mr. Swift will take charge of an irrigation project in Montana.

Mr. Frederick J. V. Skiff, Chief of the Department of Mines and Mining and Deputy Director General of the World's Columbian Exposition at Chicago, Ill., 1891-93, and connected in various capacities with several more recent expositions, has been appointed Director-in-Chief of the Panama-Pacific International Exposition to be held in San Francisco, Cal., in 1915.

Mr. J. F. Simms, formerly Superintendent of the Ozark division of the St. Louis & San Francisco R. R., has been appointed Superintendent of the Eastern division at Springfield, Mo., vice A. O'Hara, deceased; Mr. C. H. Baltzell, formerly Assistant Superintendent at Thayer, Mo., succeeds Mr. Simms at Memphis, Tenn.; Mr. B. F. Hunter, Assistant Superintendent at Enid, Okla., succeeds Mr. Baltzell at Thayer, Mo.

Mr. Holden A. Evans, Naval Constructor, U. S. N., with the rank of Lieutenant Commander, has resigned, to take effect Jan. 1. Until recently he has been Superintending Constructor at Seattle, Wash. Mr. Evans is a graduate of the U. S. Naval Academy, and made a notable record as the builder of the collier "Prometheus," at the Mare Island Navy Yard. It is reported that he will become Vice-President of the Moran Shipbuilding Co. of Seattle.

Obituary.

Thomas H. Macdonald, Consulting Engineer and Factory Manager of the American Graphophone Co., of Bridgeport, Conn., died on Dec. 4. He was an inventor of improvements to the phonograph.

James A. Milholland, formerly President of the Georges Creek & Cumberland R. R., now a part of the Western Maryland Ry., died on Dec. 7, at his home in Cumberland, Md. He was 69 years old.

John P. Van Leuven, Assistant General Superintendent of the Cincinnati Traction Co., died at his home in Cincinnati, Ohio, on Dec. 8. He was 57 years old.

Col. William A. Freeret, a former State Engineer of Louisiana and Supervising Architect of the U. S. Treasury Department in President Cleveland's first administration, died at his home in New Orleans, La., on Dec. 5. He was 79 years old and a Confederate veteran of the Civil War.

Dr. Arthur H. Koelker, formerly Associate Professor of Physiological Chemistry at Johns Hopkins University, was poisoned to death by fumes of hydrocyanic acid, in the Harriman Research Laboratory of the Roosevelt Hospital, New York City, on Dec. 7. He was born in Toledo, Ohio, in 1883. He received his doctor's degree at the University of Berlin, in Germany, in 1908, and during his short professional career had earned a wide reputation for his researches into physiological chemistry.

Prof. Engelbert Arnold, one of the most prominent electrical engineers of Europe, died on Nov. 16 at Karlsruhe, Germany. He was born at Schlierbach, Switzerland, on March 7, 1856. After a four years' course at the Institute of Technology at Zurich, 1874-78, he spent two years in engineering work. From 1880 to 1891 he was an instructor at the Institute of Technology at Riga, Russia. Besides his duties here he also had charge of the engineering department of the Russian-Baltic Electrochemical Co. Following 1891 he was for a short time Chief Engineer of the Oerlikon Co. in Switzerland. In 1894 he was made Professor at the Institute of Technology at Karlsruhe, a position which he held to the time of his death. He received the honorary degree of Doctor-Engineer from the Institute of Technology of Hanover in 1906. He made many contributions to technical literature, all published in the German language.

Warren S. Johnson, Assoc. Am. Inst. E. E., President and Treasurer of the Johnson Service Co., of Milwaukee, Wis., died in Los Angeles, Cal., on Dec. 5. He was born at Leicester, Vt., on Nov. 6, 1848. When 17 years of age his parents moved to Dunn County, Wis., where he was employed by a country newspaper. Later he became County Surveyor and County Superintendent of Schools. In 1876 he was appointed Professor of Mathematics at the State Normal School at Whitewater, Wis. Here he experimented in his private laboratory and first conceived the idea of an automatic temperature regulator. In 1883 he formed a partnership with the late William Plankinton, of Milwaukee, which two years later became the Johnson Electric Service Co., later renamed the Johnson Service Co. Besides his invention of the automatic temperature regulator which bears his name, he also devised a brass foundry furnace, a wireless telegraph system, a clock movement and various automobile accessories. Prof. Johnson was a member of the American Society of Mechanical Engineers, a member of the American Society of Heating and Ventilating Engineers, the Franklin Institute of Philadelphia and of the Milwaukee Club. He is survived by two sons, Paul F. and Carl F., who are associated with the business of their father.

Richard N. Durborow, Superintendent of Motive Power of the Pennsylvania Lines East of Pittsburgh, died at his home in Philadelphia, Pa., on Dec. 8. He had been promoted to his present position but a few months before. He was born at Philadelphia, Pa., on April 10, 1859. After attending the Cheltenham Academy and the Maryland Military Institute, he entered the railway service as an apprentice machinist in the West Philadelphia shops of the Pennsylvania R. R., in 1879. After becoming a machinist at the Altoona shops, he was transferred to the drafting room, where he spent two years. Thereafter he was successively Inspector, Assistant General Foreman and Master Mechanic of the West Philadelphia shops. On May 15, 1900, he was made Superintendent of Motive Power of the Philadelphia, Wilmington & Baltimore R. R., a subsidiary of the Pennsylvania R. R. From this position he was promoted to Superintendent of Motive Power of the Buffalo & Allegheny Valley division, and of the Eastern Pennsylvania division, and in July of this year, of all the lines east of Pittsburgh. He had nearly completed 33 years of continuous and meritorious service with the Pennsylvania R. R. system.

Engineering Societies.

COMING MEETINGS.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
Dec. 20-22. Annual meeting at Washington, D. C. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at St. Paul, Minn. Secy., J. B. Davidson, Ames, Iowa.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 3. Annual meeting at Washington, D. C. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
Jan. 6. Annual meeting at Seattle, Wash. Secy., Joseph Jacobs, 803 Central Bldg., Seattle, Wash.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 9. Annual meeting at New York City. Secy., J. R. Wemlinger, 13 Park Row, New York City.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 9. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York City.

MICHIGAN ENGINEERING SOCIETY.
Jan. 9-11. Annual meeting at Lansing, Mich. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 16. Annual meeting at Pittsburgh, Pa. Secy., Elmer K. Hiles, 3511 Oliver Bldg., Pittsburgh, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at New York City. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

SOCIETY OF AUTOMOBILE ENGINEERS.
Jan. 18-20. Annual meeting at New York City. Secy., Coker F. Clarkson, 1451 Broadway, New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 23-25. Annual meeting at New York City. Secy., W. W. Macon, 29 West 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Jan. 24-26. Annual meeting at Cleveland, Ohio. Secy., Clyde J. Knisely, New Philadelphia, Ohio.

National Electric Light Association.

A membership of 10,150 for this association was announced Dec. 7 at a meeting of the Executive Committee. At the time of the publication of a list of engineering societies in Engineering News, Aug. 3, 1911, the membership of this association was 9,214.

Society of Engineers of Eastern New York.

At the December meeting held in Albany, N. Y., Dec. 13, Mr. John D. Moore, of the New York State Conservation Commission, gave an address on "What the State of New York Is Doing for the Conservation of Its Natural Resources."

New York Electrical Society.

At the 306th meeting of this society, held in New York City Dec. 12, Dr. Louis Livingston Seaman, Major-Surgeon, First U. S. V. Engineers, gave a lecture on "A Scientific Hunting Expedition in Central Africa, with Special Reference to the Tsetse Fly and the Sleeping Sickness," illustrated by lantern slides made from photographs secured by Dr. Seaman in Africa.

Cleveland Engineering Society.

At the regular meeting of Dec. 12, Mr. Norman MacBeth, Illuminating Engineer of the Westinghouse Electric Lamp Co., Bloomfield, N. J., presented a paper on "Applications of Illuminating Engineering in Store and Factory." A paper on "Railway Signaling," by Mr. C. E. Denney, Signal Engineer, Lake Shore & Michigan Southern Ry., will be presented at the regular meeting to be held Jan. 9.

General Contractors' Association.

The third annual dinner, held at the Hotel Knickerbocker Dec. 7, was attended by over 200 members and their guests. President Charles A. Angell, of the Cranford Co., who presided, gave some inkling of the strength and influence of the association by informing the diners that its membership represented a capitalization of $87,000,000, and that the value of contracts now held by its members aggregated $340,000,000, employing upwards of 50,000 men, and that the annual pay roll last year was over $39,000,000.

The speakers for the evening were John F. O'Rourke, a member of the Executive Committee of the association; Hon. Douglas Mathewson, who told the contractors that their troubles could not always be laid at the door of public officials, as the actions of these officials were bound by the self same laws which regulate the operation of public contract work; Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City, who contrasted the crude methods of the old time contractors with the scientific operations of today; Kingsley L. Martin, Vice-President of the Foundation Co. and formerly Chief Engineer and Commissioner of Bridges of New York City, who declared that some of his views about contractors had changed very materially since he had become a contractor himself, and J. Waldo Smith, Chief Engineer of the New York Board of Water Supply, who gave an interesting talk on the organization of the engineering staff of the Board and its methods in dealing with contractors.

American Institute of Electrical Engineers.

At the 266th regular meeting in New York City, Dec. 8, Mr. G. A. Maier presented a paper entitled "Methods of Varying the Speed of Alternating-Current Motors." The paper made no pretense at being a strictly original discussion of any one feature, but was rather a careful resume of the ways and means of producing variable speed motors of this type. Different systems were described after the following classification:

(1) Induction types—squirrel cage (resistance control); squirrel cage (compensator control); double squirrel cage with one movable stator; sliding armature; polar wound armature; (2) Commutator—repulsion (resistance); repulsion (brush shifting).

The author presented his paper in very brief abstract and the time was largely devoted to short discussions of the importance of variable speed alternating-current motors.

After the discussion was concluded, almost the entire assemblage, which filled the large auditorium, adjourned to the suite of the Institute, where a social evening was spent in a way that would satisfy the most critical of those who have called the previous meetings of the Institute cold and formal.

It previously had been announced that the Directors had appropriated $50 for each such entertainment after the New York meetings. It was announced on this evening that the Board had rescinded that action on account of a previous ruling that none of the appropriations for section meetings in other cities should be spent for entertainment; it was desired to treat the New York members exactly as those elsewhere. The necessary funds were raised by subscription.